THE EFFECTS OF ROUNDUP® ON THE METABOLIC RATE OF GOLDFISH, (*Carassius auratus)*

Fiona Freeland, Connor Lindsay, Valyrie Nguyen-Cadiz, and Austin Seidl
Mentor: Dr. Tony Huntley
Department of Biological Sciences, Saddleback College, Mission Viejo, California 92692

Introduction

Recently, Bayer AG and its weed killer product, Roundup®, have been subjected to an increasingly critical re-evaluation of its safety. Much of this concern is focused on the potentially detrimental effects of glyphosate, which is the main active component in Roundup®, on consumers and marine life. Due to widespread agricultural and consumer use, aquatic organisms can be directly exposed to Roundup® by runoff from these sources, and recent evidence suggests that this exposure can affect organism function (Yusof, Ismail, and Alias, 2014). A function observed in this study is a change in the metabolic rate of glyphosate exposed organisms. It was hypothesized that the goldfish (*Carassius auratus*) subjected to Roundup® will have a statistically different metabolic rate than the control group.

Materials and Methods

16 Goldfish (*Carassius auratus)* were used in this study. Subjects were placed and allowed to acclimate in a 10-gallon fish tank for 7 days. Following the acclimation period, each goldfish's mass was measured and the fish placed individually in an experimental beaker filled with 700 mL distilled water. The dissolved oxygen concentration in the water was measured for a period of 3 minutes in triplicate using a PASCO PASPORT optical dissolved oxygen sensor (PASCO Scientific, Roseville, California), and the average mass-specific metabolic rate calculated. Roundup® was then added to the tank to create a 5 ppm solution and the fish were exposed for 24 hours before final measurements were taken (Cavas and Konen, 2007). All data was transferred to MS Excel (Microsoft Corporation, Redmond, Washington) where all further statistical analysis was performed to evaluate the results.

Results

The mean mass-specific metabolic rate of the control group was -0.000249 ± 0.0000255 mg O_2/L/sec/g (± SEM, N=16). The mean mass-specific metabolic rate of the experimental treated group treated with 5 ppm Roundup® was -0.000159 ± 0.0000238 mg O_2/L/sec/g (± SEM, N=16). There was a difference between the mean metabolic rate of the control and experimental group ($p < 0.05$, two-tailed, paired t-test).

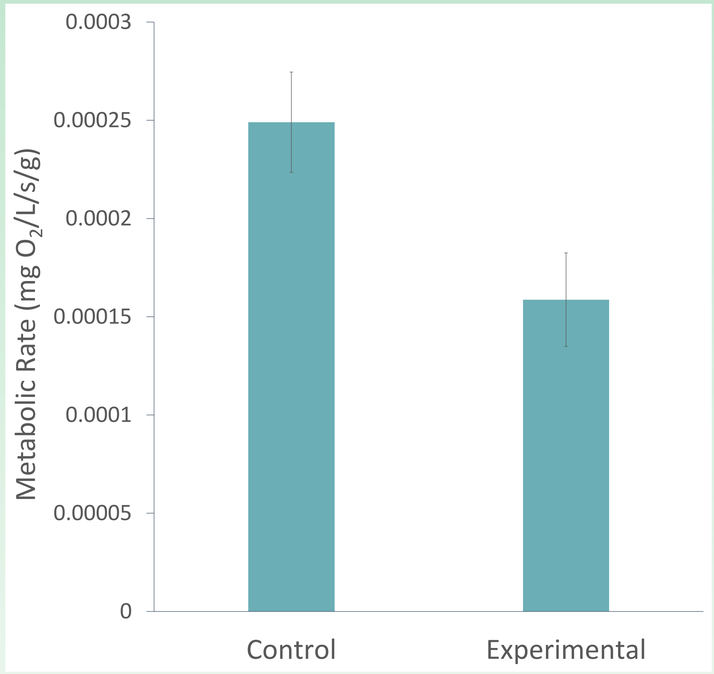

Figure 1. Mean mass-specific metabolic rate of goldfish (*Carassius auratus*). The control mean mass-specific metabolic rate was -0.000249 ± 0.0000255 mg O_2/L/sec/g (± SEM, N=16, experimental mass-specific metabolic rate -0.000159 ± 0.0000238 mg O_2/L/sec/g (± SEM, N=16). Experimental group is statistically different from the control group ($p < 0.05$, two-tailed, paired t-test). Error bars represent standard error of the mean.

Discussion

Based on the experimental results, the hypothesis suggesting the metabolic rate of goldfish treated with Roundup® at 5 ppm would be statistically different from the control was supported. The results suggest that Roundup® may be toxic to goldfish at an exposure concentration of 5 ppm for 24 hours. This result is contradictory to claims made by Bayer AG indicating that Roundup® would have no significant influence on exposed organisms due to its low toxicity. This difference in metabolic rate may be attributed to lower pyruvate kinase activity, an enzyme involved in the last step of glycolysis for cellular respiration, which would result in metabolic depression (Avigliano et. al, 2014). Further evidence and trials are required to determine the effects of Roundup® on metabolic rate conclusively as well as investigate additional potential consequences of Roundup® exposure in an aquatic environment.

Acknowledges

We would like to thank Dr. Huntley for his extensive time spent on the acquisition of materials and mentorship throughout the completion of the project.

Literature Cited

Avigliano, L., Fassiano, A. V., Medesani, D. A., Ríos de Molina, M.C., Rodríguez, E.M. (2014). Effects of glyphosate on growth rate, metabolic rate and energy reserves of early juvenile crayfish, *Cherax quadricarinatus* M. *Bulletin of Environmental Contamination and Toxicology, 92*(6), 631-635

Cavas, T., and Konen, S. (2007). Detection of cytogenetic and DNA damage in peripheral erythrocytes of goldfish (Carassius auratus) exposed to a glyphosate formulation using the micronucleus test and the comet assay. *Mutagenesis, 22*(4), 263-268.

Yusof, S., Ismail, A., and Alias, M. (2014). Effect of glyphosate-based herbicide on early life stages of Java medaka (Oryzias javanicus): A potential tropical test fish. *Marine Pollution Bulletin, 85,* 494-498.