Using Leaf Worms As A Model Organism To Study The Effects Of Caffeine

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Abstract


Figure 1
Burrowing Experiment Setup

The purpose of this experiment was to see if caffeine would affect a primitive brain the same way it does a human's highly advanced brain, and also to prove the neurological affects of caffeine. We tested this by using our different concentrations of caffeine. In order to test their behavior we used a plastic ant farm modified to be a worm raceway and turned it in a vertical position so the worms can burrow. The most important result that came from our experiment was the t-test value. The t-test was the most important result because this value showed that there was a significant difference between our control and treatment groups. The one important conclusion that we drew from this data was that when the worms were soaked in the lab grade caffeine, they burrowed further than the worms in the control group, which were the worms soaked in distilled water. We chose this test because it not only pertains to the worms, but to humans as well. This is because approximately 83% of humans drink caffeine. So, we wanted to see if caffeine actually boosted people's energy level. Leaf worms are the ideal invertebrate for our model organism in this experiment because the worms' nervous system is more primitive than ours, but they have similar tissues that make up their bodies. When the caffeine soaked into the worms, it attacks their nervous system, which also means the same for when humans drink caffeine.


Figure 2
Lab-Grade Caffeine Used in Experiment

Introduction

Our group developed a testable question for the design of the experiment. How does caffeine affect neurological and physical behaviors of leaf worms? How do they compare to humans? We used leaf worms to test the effects of caffeine on the neurological system by testing natural instincts of burrowing. Our hypothesis states that if we leave leaf worms in caffeine solution soaked dirt for five minutes, then they will burrow deeper in less time than those put in distilled water soaked dirt. We predict this because leaf worms have a natural tendency to burrow (Beans, 2014), and based on our research, caffeine affects the neurological feeling of tiredness. 'Tiredness' is actually caused by adenosine, a chemical that is released in the brain when energy is expended (Hernandez, 2015). Caffeine stops the production of adenosine, and thus makes one feel more awake. (Roberts, 2009) We predicted that the worms would be affected in the same way as humans, and therefore would burrow faster because of the perceived boost in energy. However, the worms may burrow the same amount as the control, since the worms' brains are much less advanced than a human's, and the caffeine would not affect the behavior of the worms and their natural instinct to burrow.

Methods

In our experiment, we used a variety of materials. First, we needed to have our worm raceway (Fig.1) so we could measure how far the worms burrowed in 15 minutes. We not only needed that, but we obviously needed the soil to put on the raceway. Next, we needed the worms, distilled water, and the lab grade caffeine powder (Fig. 2). We had to soak the worms in a concentration of caffeine in order to determine if the caffeine really does affect the burrowing behavior. In order to get the caffeine to the concentrations of 1,000, 10,0000, and 100,000 parts per million, we need to first calculate the amount of water per gram of caffeine, then make a small amount of solution for each concentration. Once we got the concentration that we wanted, we filled each Petri dish relatively full of soil and soaked one of the Petri dishes with the caffeine solution and the other Petri dish with distilled water. Once the soil was moisturized with distilled water and the caffeine, we placed two worms in each Petri dish and set a timer for five minutes. By the end of the five minutes, the caffeine had soaked into the worms' skin and affected their neurological system. After that, we placed a thin layer of soil onto the raceway 16 centimeters up from the bottom. When the timer was up, we moistened each side of the raceway with distilled water and placed the two worms that were in the caffeinated soil onto the treated side of the raceway and the control worms (which were soaked in the distilled water) and placed them on the control side of the raceway. After, we capped the raceway and turned it vertical. As soon as we turned the raceway to a vertical position (Fig. 1), we started a timer for 15 minutes. At the end of 15 minutes, we measured the distance from the top of the soil to any worms that did not make it to the bottom in 15 minutes. Thereafter, we had to find the t-test value of our data to determine the significance between the control group and the treatment group.

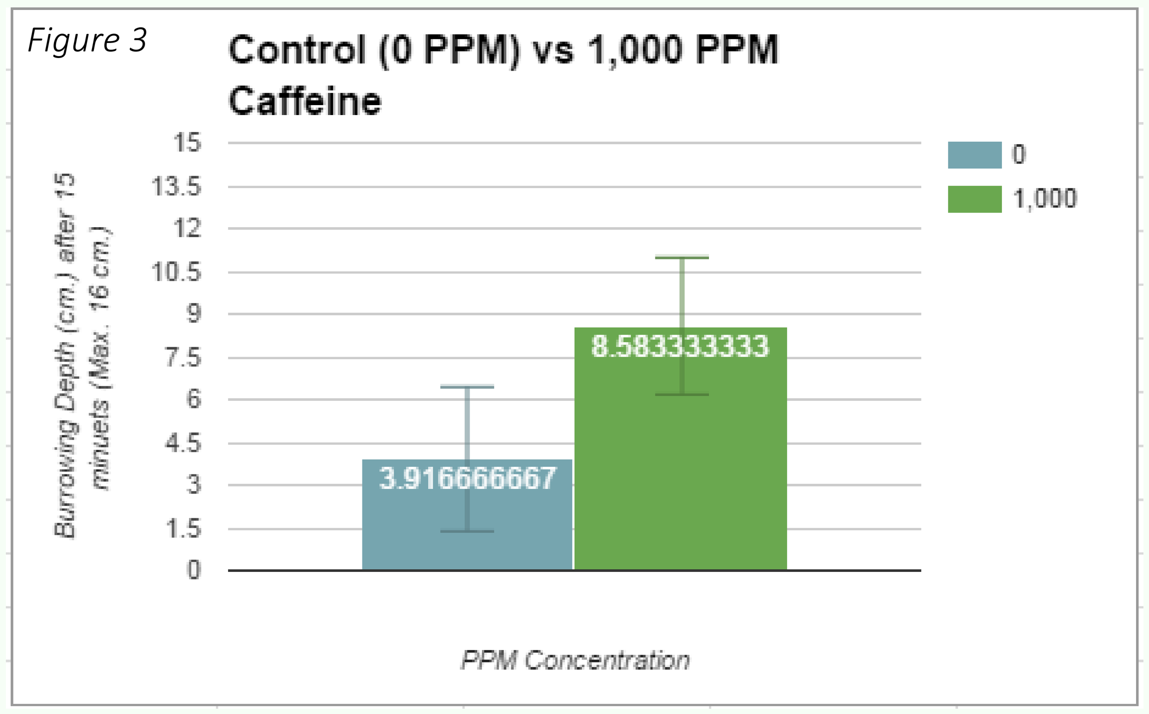
Figure 3


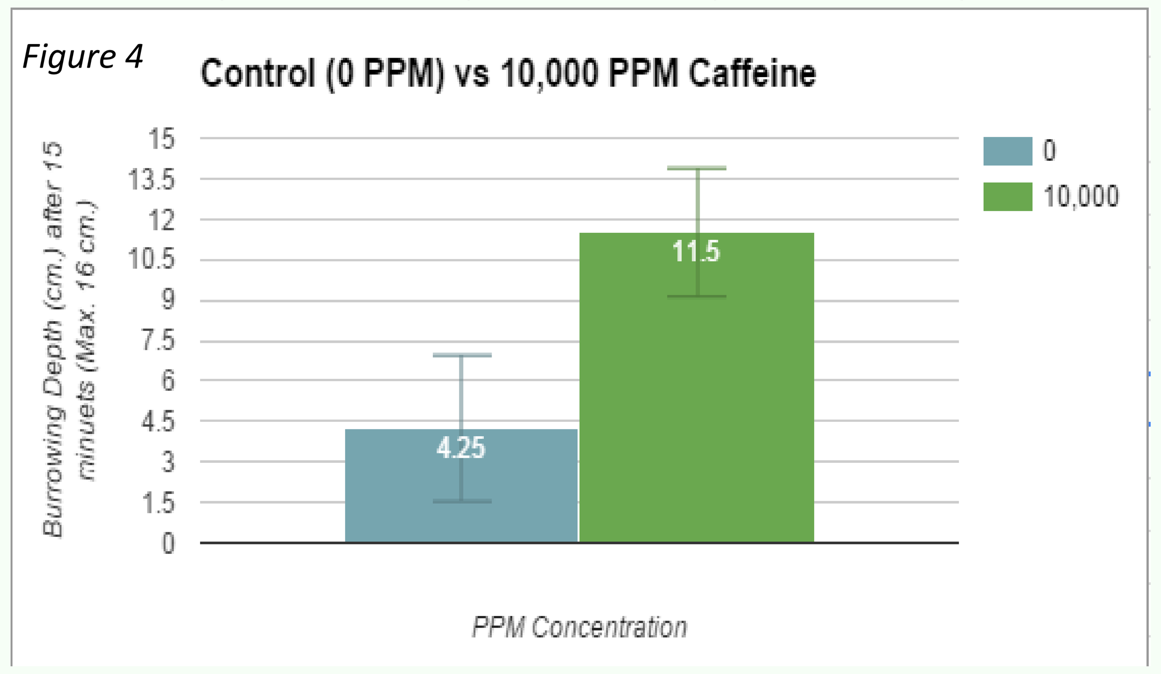
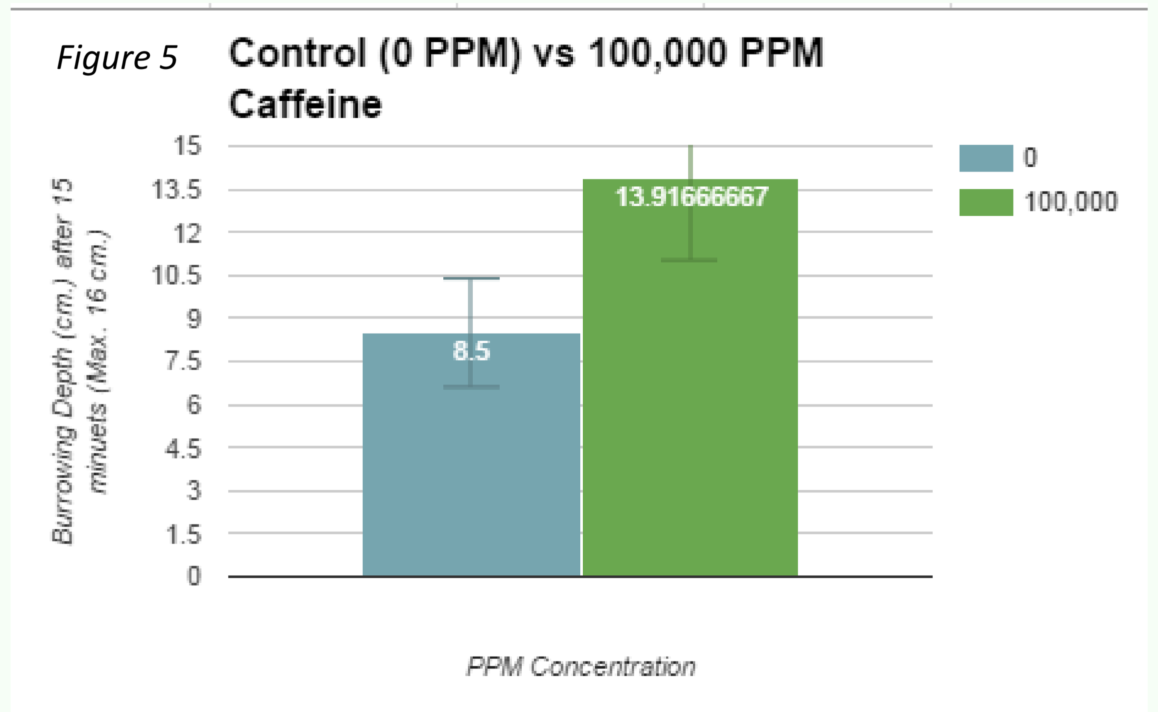
Figure 4


Figure 5


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Results

In our experiment we had some results that supported our hypothesis and some results that did not support our hypothesis. The first test that we did was when we tested water (0 PPM) and caffeine at 1,000 PPM. Our t-test value for the first experiment was 0.211 and that shows no significant difference as shown in figure 3. In our second test we saw we had results that supported our hypothesis. When we tested 10,000 PPM, we had an average of 11.5 cm for the caffeine and only an average of 4.25 cm. Our t-test value was 0.072 this is a significant difference as shown in figure 4. For our last test we tested 100,000 PPM and water. There was a significant difference with a p-value of 0.152 in the average burrowing depth, the caffeine 100,000 PPM was 13.92 and the water was only 8.25 as shown in figure 5. Our control in our experiment was soaking them in the distilled water for 5 minutes, and soaking them in the caffeine for five minutes. Our independent variable was the PPM for caffeine and the dependent variable was the burrowing depth of the worms. Overall, our most important values were the p-values for the t-test. We found a significant difference between control and treatment groups in our second and third concentrations of the caffeine.

Discussion

When we first came up with this idea we wondered how far worms would burrow if we soak them in caffeine versus water. We then decided that if we test if worms soaked in caffeine and water then we think that if we soak them in caffeine they will burrow faster because the caffeine will affect their primitive brains and cause them to have a false sense of more energy. Our research question was answered through the data that we found and our hypothesis was proved correct. We decided doing the burrowing experiment would help us prove it the most. We did not run into any experimental problems, but to better track activity, we thought a good future experiment would be to measure their total movement, not just burrowing. Our data does agree with the accepted science data (Figures 3-5). With the data that we found it shows that they did tend to go further when they were soaked in the caffeine versus just being soaked in water. Our data and results provided mostly significant differences between the control and treatment groups. When we conducted our experiment we got significant results proving our hypothesis that when the worms are soaked in caffeine they will burrow deeper in a shorter amount of time. One pattern in our data clearly connected to our hypothesis; they tend to burrow more when being soaked in caffeine. Looking at our graphs you can tell that they tended to burrow more when they were caffeinated. Another observed pattern is the worms abandoning their natural burrowing behavior. Some worms burrowed nearly to the bottom, then abruptly turned around and headed upwards. This occurred occasionally with both control and treatment groups, but more so with the treatment on any concentration. This proves that the caffeine affects the worms' neurological system and can change their natural behavior. Similarly, caffeine affects a human's brain by changing the neurological pattern of feeling tired and needing to sleep, therefore creating an artificial boost in energy (Hernandez, 2015). Our experiment clearly proves that caffeine affects organisms with less-advanced nervous systems by damaging or changing regular habits and behaviors.