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## **How Do Energy Drinks Affect the Burrowing Time of Redworms?**

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## **Abstract**

Caffeine is the world's most popular drug and it's used all around the world in various forms. One of the most popular forms is energy drinks. They are meant to give you a burst of energy when you need it most, but they do more than that. Caffeine blocks your adenosine which keeps you from getting tired. But, caffeine isn't all good. It can cause stomach problems, headaches, dizziness, skin allergies, and an increased risk of bleeding. and bruising. So the scientists decided to test the effects of caffeine on Redworms. The results would surprise you. When the Redworms were exposed to caffeine they slowed down. To do the experiment the scientists exposed The worms in an exposure chamber with 2 ML of the contaminant, energy drinks. Then the worms were put in the burrowing chamber where their burrowing time was recorded. The data showed that no matter the amount the energy drink always slowed down the worm. Which is strange right? Aren't energy drinks supposed to speed you up? That wasn't the case. The Redworms move slower because the Caffeine disrupts the worm's natural body processes. As a result, the worm's brain fights back to the overstimulation by producing even more adenosine. So, the worms felt sleepy and tired after they were exposed. Likely, some of the worms moved slower because of their gene type or possibly overdosing because of their small size. In addition, outliers could have occurred because of previous testing or conditions that they already had. Lastly, the research is limited because of tight time constraints.

## **Introduction**

In this lab, the scientist's goal was to find the effects of energy drinks like Monster Energy, 5 Hour Energy, Redbull, and Bang on worms' locomotion. The main purpose of the experiment was to find the effect of caffeine and other energy drink ingredients on the body and nervous system. The purpose was to find the effect of caffeine and the other ingredients of energy drinks of worms, to learn about

possible effects on humans. Being that caffeine is a stimulant it increases activity in the brain. Caffeine is meant to help you wake up, have more energy, and make it through your day. Caffeine is a neurochemical that blocks adenosine <sup>1</sup>. Adenosine is the messenger that tells your body when to rest and relax meaning that caffeine blocks out the ability to rest making you less tired and giving you more energy. The effects of caffeine are short-lasting though. Once the caffeine stops blocking adenosine you crash and become very tired. Caffeine is the world's most popular drug because it gives you energy and helps people move through their day. In addition, 40 percent of teens had had an energy drink in the last 3 months <sup>2</sup>.

energy drinks are made of numerous chemicals and ingredients. Some good and some bad. For example, most energy drinks have Guarna which can give energy and better memory, but with a high chance of high blood pressure, heart rate, and even a chance at cardiac arrhythmias. energy drinks also contain B vitamins which help improve brains functions and increase energy levels. Green tea extract can improve blood flow and lower cholesterol. Most energy drinks also contain Ginkgo Biloba which causes stomach problems, headaches, dizziness, skin allergies, and an increased risk of bleeding and bruising. Lastly, the USDA has said that in an 8oz can Redbull has 111 mg of caffeine, Monster Energy has 225mg of caffeine, Bang has 225 mg of caffeine, and 5-hour energy has 1450mg of caffeine <sup>3</sup>.

Energy drinks have many positive and negative effects on the body. Caffeine and guarana energy drinks It is used by millions every day to improve mental alertness, cognitive functions, endurance, reaction

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<sup>1</sup> "caffeine - News24." <https://www.news24.com/Tags/Topics/caffeine>. Accessed 11 Jan. 2022.

<sup>2</sup> "Teens Are Probably Drinking Too Much Caffeine - The Atlantic." 30 Jun. 2019, <https://www.theatlantic.com/health/archive/2019/06/scientists-say-energy-drinks-ads-shouldnt-target-teens/592657/>. Accessed 12 Jan. 2022.

<sup>3</sup> "Food Data Central - USDA." <https://fdc.nal.usda.gov/>. Accessed 12 Jan. 2022.

time, and physical performance.<sup>4</sup> It's not surprising it's the world's most popular drug. But that's not to say it doesn't have its issues. Some short-term effects of energy drinks are high blood pressure, high heart rate, anxiety, heart disease, and insomnia<sup>5</sup>. In addition when energy drinks and caffeine are taken for a long time then people can start to have long-term effects like chronic insomnia, constant anxiety, depression, and stomach problems. It can also cause high blood pressure or make high blood pressure worse<sup>6</sup>. Since caffeine is addictive it does have withdrawal effects like headaches, fatigue, low energy, irritability, anxiety, poor concentration, depression, and tremors. These symptoms can last anywhere from two to nine days.<sup>7</sup>

Because of the negative effects of energy drinks and caffeine, they are made out of some scientists who decided to test the effects of caffeine and energy drinks of redworms using Bang, Monster, 5 Hour Energy, and Redbull. The scientists used worms because a worm's muscular system is very similar to humans. The scientists wanted to find the effects of caffeine and energy drinks on redworms because of the rising trend in today's youth. In America, a chemical is called safe until proved otherwise so the scientists wanted to make sure society knew the effects of these new drinks. If scientists exposed redworms to energy drinks, then it would increase the time it takes for an earthworm to burrow, because energy drinks have high levels of caffeine which the scientists believed would disorient and confuse the redworms, in effect slowing them down. The scientists found that the caffeine slowed the worms down. When the worms were exposed they burrowed slower. The scientists also found that

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<sup>4</sup> "Do You Know... Caffeine - CAMH." <https://www.camh.ca/-/media/files/guides-and-publications/dyk-caffeine.pdf>. Accessed 11 Jan. 2022.

<sup>5</sup> "CAFFEINE: Overview, Uses, Side Effects, Precautions, Interactions." <https://www.webmd.com/vitamins/ai/ingredientmono-979/caffeine>. Accessed 12 Jan. 2022.

<sup>6</sup> "Substance Use: Caffeine - MyHealth Alberta." <https://myhealth.alberta.ca/Alberta/Pages/Substance-use-caffeine.aspx>. Accessed 12 Jan. 2022.

<sup>7</sup> "8 Symptoms of Caffeine Withdrawal - Healthline." <https://www.healthline.com/nutrition/caffeine-withdrawal-symptoms>. Accessed 12 Jan. 2022.

there was a perfect median that let the worms burrow faster. When the worms were exposed to 25% they burrowed faster than any other amount of energy drink.

### **Materials**

- 16 Oz Plastic Cups
- Coffee filters
- Adult Red worms from Carolina Biological Supply
- Scissors
- Pencil
- 2 ml dropper
- Redbull
- Bang Energy
- Monster Energy
- 5 Hour Energy
- Garden Dirt
- Water
- Eye-Protection
- Beakers(50 ml)
- Styrofoam trays

### **Methods**

Step 1. The first step to testing the worms is to create the exposure chamber. (See Below)

Step 2. Secondly, add moist dirt to a cup to create the burrowing chamber.

Step 3. Next, add the 2 ml desired liquid (energy drink) into the exposure chamber. Put the second filter on top and close the chamber by adding the cup atop the filter.

Step 4. Then you add the worms and start a timer for the desired amount of time. (1,2.5, or 5 mins)

Step 5. Remove the worms when the timer has elapsed and add them to the burrowing chamber.

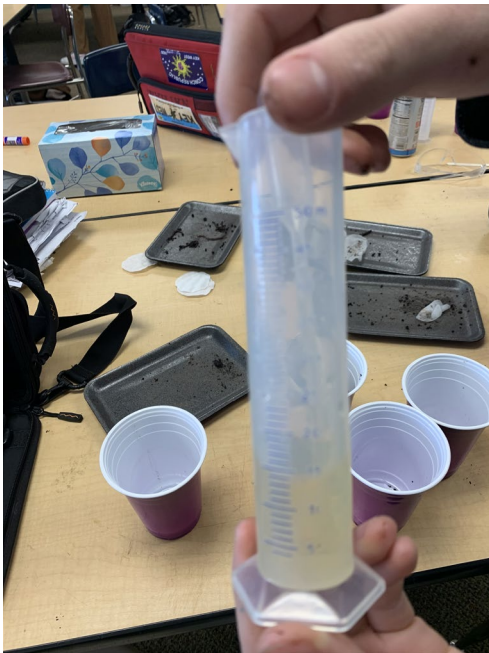
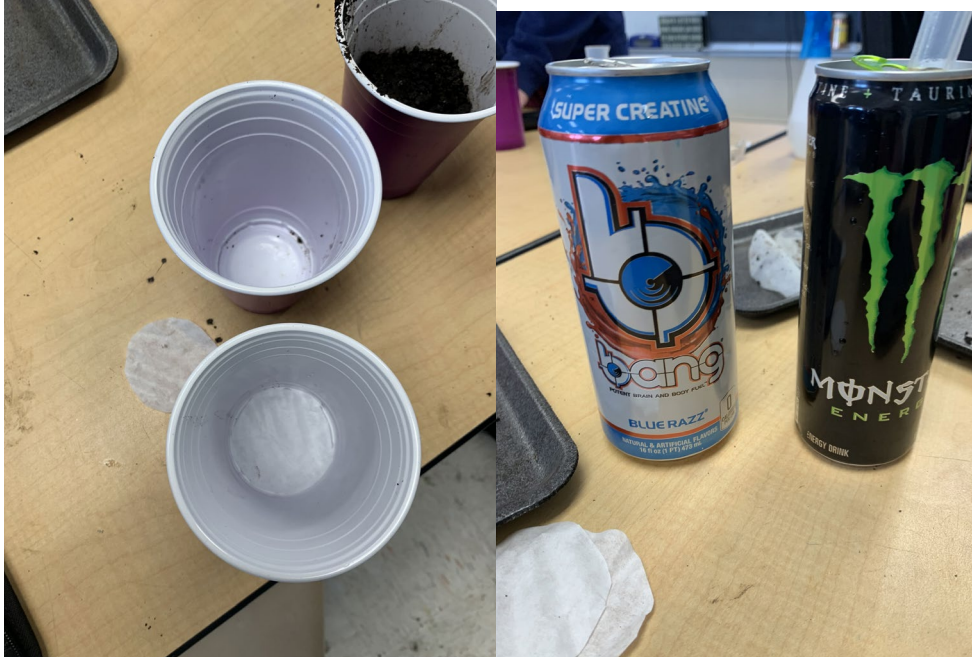
Step 6. Start a timer then record when each worm burrows.

Step 7. Once each worm burrows, remove them from the cup and put them back into a separate tray of dirt.

Step 8. If 2 or more worms were tested then add all the totals up and average them to find the average burrowing time for the liquid and duration.

Step 9. Then repeat the process with all contaminants and exposure times.

(Red Bull, Bang, Monster, 5 Hour Energy)



### Safety

Safety is always a critical factor in any experiment. In this experiment, we used Eye wear to keep our eyes safe in case any of the liquids were to land in our eyes. We also cleaned the table to make sure any dirt or energy drink remained which could possibly mess with a later experiment. Another safety

precaution that we took was to keep any hair or clothes clear of the workspace to keep us free of contamination.

**How to Create an Exposure chamber.** Firstly you cut out the Coffee filter in the shape of a circle using the base of the cup as a reference to cut. You then take a circle of filters and place it in the bottom of the cup. You then insert 2 ml of a liquid. Then put the desired amount of worms in the chamber. Lastly, put the second filter on top of the worms and put a second cup on top of the filters and worms.

### **How to create solutions**

To create the 50% solution the scientists added 10 ml of water and 10 ml of energy drink into a 50 ml beaker. To create the 25% solution the scientists added 15 ml of water and 5 ml of energy drink into a 50 ml beaker. To create the 5% solution the scientists added 19 ml of water and 1 ml of energy drink into a 50 ml beaker.

### **Results**

In the experiment Redbull, Monster, Bang, and Five Hour were tested to understand the negative effects of caffeine and Guarna on humans. Caffeine is a stimulant which means that it speeds up messages in the brain. Caffeine functions by blocking the effects of adenosine, which is a neurotransmitter that relaxes the brain and makes you feel tired <sup>8</sup>. Caffeine can cause heartburn, nausea, vomiting, diarrhea. muscle aches.<sup>9</sup>

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<sup>8</sup> "The Effects of Caffeine on Your Body - Healthline." <https://www.healthline.com/health/caffeine-effects-on-body>. Accessed 7 Feb. 2022.

<sup>9</sup> "The Effects of Caffeine on Your Body - Healthline." <https://www.healthline.com/health/caffeine-effects-on-body>. Accessed 7 Feb. 2022.



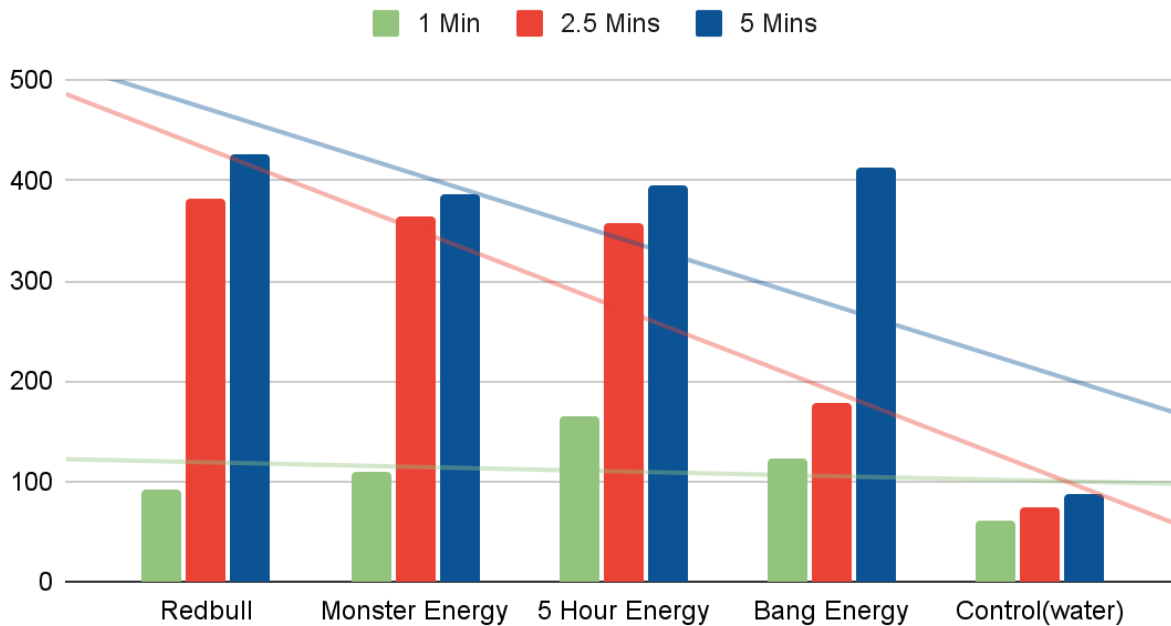
Caffeine is the world's most popular drug and nowadays, 80% of the world's population consumes a caffeinated product each day, and this number goes up to 90% for adults in North America.<sup>10</sup> So an experiment was conducted to see the negative results of the drug on redworms which could then be transferred to studies on humans. The scientist's hypothesis stated that if scientists exposed redworms to energy drinks, then it would increase the time it takes for an earthworm to burrow because energy drinks have high levels of caffeine which the scientists believed would disorient and confuse the redworms, in effect slowing them down. The scientists thought that the caffeine and guarana would crash the worms quickly because they were so much smaller than humans. The crash would result in tiredness and a slower burrowing speed.

In the experiment, the scientists used exposure chambers to contaminate the redworms with energy drinks. They started by creating the exposure chamber (Above) then adding 2ml of one of the 5% energy drink, 25% energy drink, or the 50% energy drink. The scientists then closed the chamber and waited for the exposure time to elapse. The scientists then grabbed the worms and placed them inside the burrowing chamber where the scientists recorded how long it took for the worms to burrow.

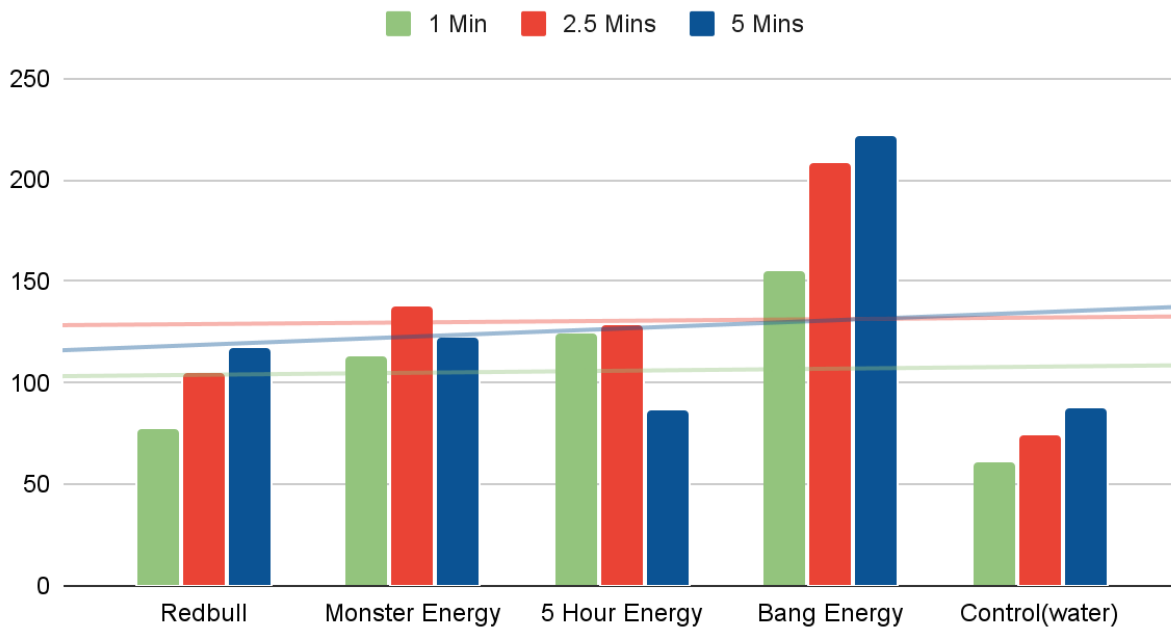
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<sup>10</sup> "The Effects of Caffeine on Your Body - Healthline." <https://www.healthline.com/health/caffeine-effects-on-body>. Accessed 7 Feb. 2022.

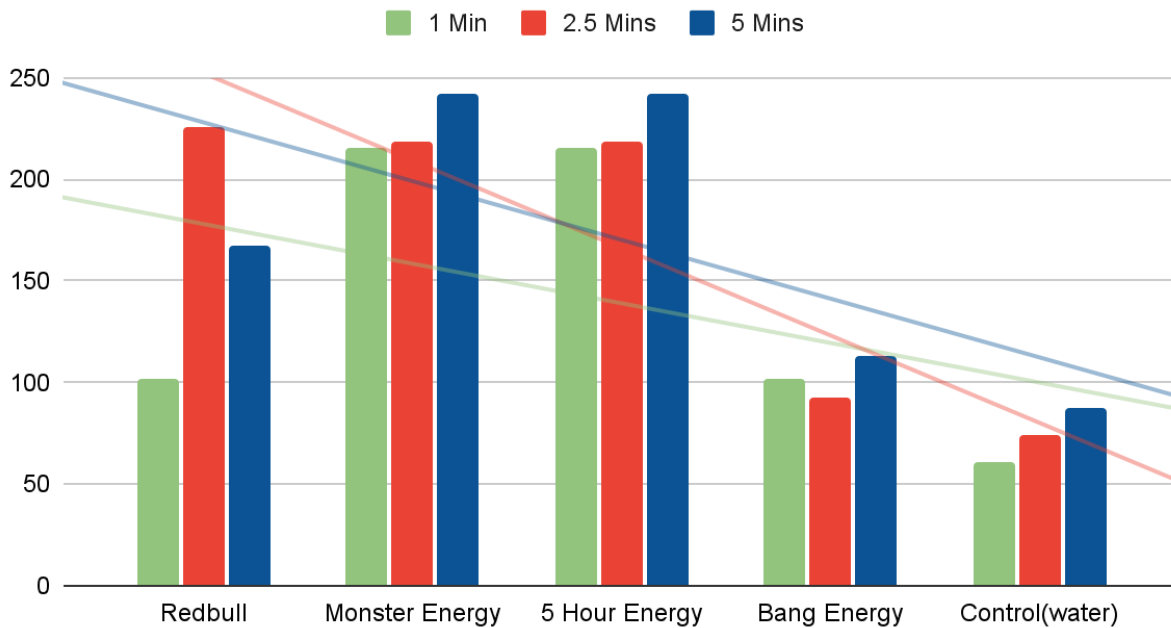
## Earth Worm data chart for 5% Energy Drinks



## Earthworm Data chart for 25% Energy Drink



## Earth Worm Data chart for 50% Energy Drink



Earth Worm Data chart for 5%				
	1 Min	2.5 Mins	5 Mins	
Redbull	91	383	426	
Monster Energy	109	364	386	
5 Hour Energy	166	357	396	
Bang Energy	123	178	412	
Control(water)	61	74	87	
Earth Worm Data chart for 25%				
	1 Min	2.5 Mins	5 Mins	
Redbull	77	105	117	
Monster Energy	113	138	122	
5 Hour Energy	124	128	86	

Bang Energy	155	208	222	
Control(water)	61	74	87	
	Earth Worm Data chart for 50%			
	1 Min	2.5 Mins	5 Mins	
Redbull	102	226	167	
Monster Energy	215	219	242	
5 Hour Energy	215	219	242	
Bang Energy	102	93	113	
Control(water)	61	74	87	

Solution	Exposure Time	Mean	t-score	Statistically Significant?
5% Red Bull	1 min	91	2.5948	Statistically Significant
5% Red Bull	2.5 min	383	26.7268	Statistically Significant
5% Red Bull	5 min	426	29.3216	Statistically Significant
5% Monster	1 min	109	4.1517	Statistically Significant
5% Monster	2.5 min	364	25.0834	Statistically Significant
5% Monster	5 min	386	25.8619	Statistically Significant
5% Bang	1 min	123	5.3627	Statistically Significant
5% Bang	2.5 min	178	7.2655	Statistically Significant
5% Bang	5 min	412	28.1107	Statistically Significant

5% Five Hour	1 min	166	9.0819	Statistically Significant
5% Five Hour	2.5 min	178	7.2655	Statistically Significant
5% Five Hour	5 min	412	28.1107	Statistically Significant
25% Red Bull	1 min	77	1.3839	Statistically Significant
25% Red Bull	2.5 min	105	2.6813	Statistically Significant
25% Red Bull	5 min	117	2.5948	Statistically Significant
25% Monster	1 min	113	4.4977	Statistically Significant
25% Monster	2.5 min	138	5.5356	Statistically Significant
25% Monster	5 min	122	3.0273	Statistically Significant
25% Bang	1 min	155	8.1305	Statistically Significant
25% Bang	2.5 min	208	11.5903	Statistically Significant
25% Bang	5 min	222	11.6768	Statistically Significant
25% Five Hour	1 min	124	5.4492	Statistically Significant
25% Five Hour	2.5 min	128	4.6707	Statistically Significant
25% Five Hour	5 min	86	0.0865	Not Statistically Significant
50% Red Bull	1 min	102	3.5463	Statistically Significant
50% Red Bull	2.5 min	226	13.1472	Statistically Significant
50% Red Bull	5 min	167	6.9196	Statistically Significant

50% Monster	1 min	215	13.3202	Statistically Significant
50% Monster	2.5 min	219	12.5417	Statistically Significant
50% Monster	5 min	242	13.4066	Statistically Significant
50% Bang	1 min	61	0.0000	Not Statistically Significant
50% Bang	2.5 min	74	0.0000	Not Statistically Significant
50% Bang	5 min	87	0.0000	Not Statistically Significant
50% Five Hour	1 min	102	3.5463	Statistically Significant
50% Five Hour	2.5 min	93	1.6434	Statistically Significant
50% Five Hour	5 min	113	2.2489	Statistically Significant

In the experiment there were various trends and patterns. A pattern throughout was the greater the energy drink the longer it took for the worms to burrow. This was not always the case though. In 25% energy drink something interesting happened. All the worms started to burrow faster. A common trend that was noticed was that the control always took less time. But as the energy drink increased the worms started to burrow faster. The data supported the hypothesis by saying that the energy drink would make the worms burrow slower, which is exactly what happened. When the worms were exposed they took longer. Something unexpected happened though, when the worms were exposed to 25% they were faster than the worms exposed to 5% and 50%. The results showed that the worms were slower when exposed to energy drinks, thus the goal of the experiment was to see whether the drinks speed up the worms, slowed them down, or didn't affect them at all. A possible outlier could be the Redbull 50% because the RedBull was open a day before the test was done for 50% percent, meaning

that other things could have gotten in and the Redbull could be more or less potent after the air exposure.

Some possible outliers could have been the control and the 25% energy drink data. Since the worms were reused in the experiment the worms may have already been tested on by extreme chemicals. This means that the worms could have been tested on pure caffeine which could have affected the data. It is also possible that the worms had been tested on with nicotine, which would immensely slow down the burrowing. One limitation to the experiment was the time constraint. The scientists only had 1 hour at a time and on the first day, we had opened the RedBull and let it sit open, which could have possibly messed up the data by 50%.

## **Discussion**

In the entire experiment the main trend that accrued was, energy drinks slow down the Redworms. In each trial, the scientists learned that the worm burrowed faster when exposed to 25% energy drink. (On average). Another noticeable pattern was how the worms burrowed slower when exposed to very little energy drink and lots of energy drink. Besides for the 50% bang which was an outlier. The original question was, what are the effects of energy drinks on redworms. The scientists then tested this by using 3 different exposure times, 3 different energy drink amounts, and 4 different kinds of drinks. It was hypothesized that if scientists exposed redworms to energy drinks, then it would increase the time it takes for an earthworm to burrow because energy drinks have high levels of caffeine which the scientists believed would disorient, confuse, and make the redworms crash quickly because of their small mass. The redworms would be slowed down. The data the scientists then recorded was then used to determine the factuality of the hypothesis the scientists deemed to be correct. With the data presented they believed their hypothesis to be correct.

A main limitation in the experiment was the time factor. With only 3 time lengths it isn't possible to have the effect of more caffeine and longer exposure. Another limitation was the worms themselves. Without the ability to know whether they had been tested it's possible the data could have been inaccurate. The final main limitation was human error. The 5% energy drink could likely be 5.6% energy drink and 94.4% water which could change the data slightly or majorly. You never know what could possibly have gone wrong during a prolonged experiment.

The earthworms increased in burrowing time for multiple reasons. When the worms were placed in the burrowing chamber they seemed confused, tired, and often they phased off and started acting crazy. The most likely reason why they burrowed slower and acted this way was because Caffeine disrupts your body's natural processes. As a result, your brain fights back to the overstimulation by producing even more adenosine. So, you feel sleepy and tired directly after having an energy drink. Another reason could be an overdose of caffeine. The caffeine would block the adenosine and therefore once the caffeine stopped all of the stored up adenosine would flood out overwhelming the worms with tiredness, and sleepiness because adenosine is the chemical that tells you when to go to sleep and when you are tired. Another reason why the earthworms burrowed slower is that caffeine causes less oxygen to enter the brain <sup>11</sup>. Without oxygen to the brain, the worms can lose consciousness which would slow them down immensely. Another factor to consider is a worm's gene type. Some people have different gene types which makes them react differently to caffeine. Studies have found

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<sup>11</sup> "Spilling The Beans: Why Coffee Is Actually Slowing You Down ...." 24 Sep. 2014, <https://www.elitedaily.com/life/coffee-slowng-you-down/771695>. Accessed 16 Feb. 2022.



that depending on your gene type you might move slower when exposed to caffeine, or faster when exposed.<sup>12</sup>

The scientists believed that the data from the experiment was important for society to know. Caffeine is the world's most popular drug and it can have many negative effects on the human body and mind. In a survey by NCBI, they found that almost 41% of teens had energy drinks in the last month<sup>13</sup>. Energy drinks are relatively new and this experiment was to see the effect of energy drinks on redworms, creatures with very similar muscle structures to humans to possibly look into the short and long term effects to our youth today. This data could benefit scientists and society on many levels. It could make younger people realize just how much caffeine can affect your body. Caffeine is looked over because so many people have it every day and rely on it to perform basic functions. This is why so many people are affected, so many people use it so they don't feel it's bad.

Even after research is done more is always of use. To further work on this topic time will be a critical factor letting us test more types, percents, and options. To further their research the scientists plan to try to experiment with different animals. The world is growing and we have to keep experimenting!

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<sup>12</sup> "How caffeine could slow you down - Runner's World." 16 Jun. 2016, <https://www.runnersworld.com/uk/a774998/how-caffeine-could-slow-you-down/>. Accessed 16 Feb. 2022.

<sup>13</sup> "Caffeinated energy drink Use by US Adolescents Aged 13-17 - NCBI." 1 Sep. 2019, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6136946/>. Accessed 17 Feb. 2022.