How Does Blue Food Dye Affect an Earthworm's Burrowing Time?

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Abstract

In this experiment the scientist tested the contaminant of food dye on an earthworm. They tested an earthworm's locomotion and burrowing time. They did this because it is an environmental agent in the world that can affect humans. Food dye can be linked to Attention Deficit Disorder (ADD), allergies, learning impairment, irritability, and aggressiveness. As time goes on people are using food dye in more and more foods such as taffy, frosting, macaroni and cheese, sports drinks, cereal, candy and many more. Since worms have a similar nervous system to humans, they tested food dye on worms. The scientists exposed the worm to this contaminant by putting it in an exposure chamber with different food dye dilutions. Below in the document it explains how to do everything with a complete description on how to make an exposure chamber, how to dilute, and a procedure on the experiment. They recorded how long it took the worm to burrow after being exposed to different dilutions of food dye for different periods of time. In the end, the scientist found that the worm burrowed at all different times when exposed to different dilutions of food dye. The scientists found out this happened because the nervous system of the worm got affected and caused the worm to become hyperactive. The scientist wanted others to know more about how food dye can affect a human's nervous system along with other parts of the body.

Introduction

A single child can consume up to 100 milligrams of food dye in one meal.[1] There are food dyes everywhere--taffy, frosting, macaroni and cheese, sports drinks, cereal, and many more. Even some types of bread use food dye. In this experiment, the scientist

[1] "Just How Much Dye Is in Your Food? - Modern Farmer." 22 May. 2014, https://modernfarmer.com/2014/05/just-much-dye-food/. Accessed 24 Feb. 2021.

focused on blue food dye.[2] There are two types of food dye--Blue No. 1 and Blue No. 2. Blue No. 1, known as “Brilliant Blue,” was originally made from coal tar, but now most manufacturers make it from an oil base. Blue No. 2 known as “Indigotine” was made from a synthetic version of the plant-based indigo that has a long history as a textile dye. The chemical in blue food dye is indigotine. In this experiment the scientist used Blue No. 1. Food dye is an environmental agent meaning people are exposed to this chemical on a daily basis. This substance affects people in a negative way.[3] Synthetic food dyes are especially bad for children.[4] The food that people eat has lots of food dye in it. But, if it didn’t have dye in it, people could be eating something like pink butter. People's minds make them want to eat something with a color that matches it’s taste. This is why companies don’t take out the food dye in people’s food.[5] Food dye affects the nervous system, and when it does, people can become hyperactive. It can also be linked to Attention Deficit Disorder (ADD), allergies, learning impairment, irritability, and aggressiveness. One study found that 75% of parents noticed that their children's behavior and attention were better when they took away food dyes. Another study found that kids who ate food dye before a test ended up performing worse on the test than the kids who didn’t eat food dye. Some other things that food dye can do is it can lead to extra calories and fat. Some more major side effects of some food dyes is that it can cause cancer. Also, some scientists

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[2] "The Hidden Health Risks of Food Dyes | EatingWell." 8 Oct. 2010, https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 9 Feb. 2021.
[3] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 9 Feb. 2021.
[4] "The Hidden Health Risks of Food Dyes | EatingWell." 8 Oct. 2010, https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 9 Feb. 2021.
[5] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 9 Feb. 2021.

found tumor growth in animals that consumed food dye.[6] These negative effects of food dye made some scientists want to test food dye on the burrowing time of earthworms. A human's nervous system is similar to a worm's nervous system and this is why the scientist used a worm for the experiment.[7] This experiment is very important for society to know about. This is important because food dye is an environmental agent and we are exposed to it daily. If the experiment is tested on a worm who has a similar nervous system to humans, people could know if this substance is hurting humans and their nervous system. This is important because the nervous system is a vital part of movement, balance, sensation, thinking, and coordination.[8] The scientists wanted to see how long it took for an earthworm to burrow when being exposed to food dye. Their hypothesis for this experiment is if an earthworm is exposed to food dye then it would affect the worm's locomotion at a faster or slower speed and affect its burrowing time. They believe that the worm will burrow at different speeds. The scientist believes this because the consumption of food dye is linked to ADHD and can cause hyperactivity.[9] Although the scientist did not have time to finish diluting all the way up to 100%, they had enough data to back up their hypothesis. The scientist's results for this experiment were all over the place meaning sometimes the worm took a long period of time to burrow and other times it took a very short period of time to burrow. The scientists found out that the worms had different behavioral changes. For the

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[6] "The Hidden Health Risks of Food Dyes | EatingWell." 8 Oct. 2010, https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 9 Feb. 2021.
[7] "Earthworms, Salamanders and Humans: A Pathway to New ...." 30 Apr. 2018, https://ysjournal.com/earthworms-salamanders-and-humans-a-pathway-to-new-discoveries/. Accessed 9 Feb. 2021.
[8] "Nervous System Problems | Michigan Medicine." https://www.uofmhealth.org/health-library/nersp. Accessed 21 Feb. 2021.
[9] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 9 Feb. 2021.

most part the longer the worm was in the exposure chamber and when the dilutions went up

, the cazier the worm's locomotion got.

Materials and Methods

Materials

- Three twenty ounce plastic solo cups
- Blue food dye from Pick n Save
- Three adult earthworms
- Two large sized coffee filters
- Ten ounces of dirt - Room temperature
- Approximately one hundred mL of pure water
- One two mL pipette
- One ten mL graduated cylinder
- Three timers
- One styrofoam tray
- One spray bottle
- One exposure chamber (See below on how to make)
- Dilutions of food dye (10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%). (See below on how to make)

How to make an exposure chamber

Step One:
Take one twenty ounce cup and trace the bottom of the cup on a coffee filter twice, and cut both of them out.

Step Two:
Take the cut out coffee filters and the dilution being used. Use the pipette to get two mL of the dilution and put the dilution on the two cut out coffee filters.

Step Three:
Take one of the soaked coffee filters and place it in the bottom of one twenty ounce cup. Place three worms in the cup. Then put the other soaked coffee filter on top of the worms. Note: Make sure that the worms are completely covered by the coffee filters.

Step Four:
Place another cup on top of the worms so that the cups are stacked together. Leave the worms in the chamber for the desired time. (One minute, five minutes, ten minutes, or twenty minutes.)

Step Five:
Repeat these steps for 10-100% dilution and for all of the times listed above.

How to make dilutions for 10-100%

Step One:
To make a 10% dilution, take a ten mL graduated cylinder and put nine mL of water in the graduated cylinder. Then, put one mL of blue food dye in the graduated cylinder.

Step Two:
Repeat step one for all dilutions 10-100%.

Methods

Step One:
Make the dilutions for 10-100% of food dye. (See the subtitle “How to make dilutions for 10-100%” on how to do this.)

Step Two:
Prepare four different exposure chambers. Keep the worms in the exposure chambers for one minute, five minutes, ten minutes, and twenty minutes.

Step Three:
Once the time is up, place the worm in a twenty ounce cup with 10 ounces of dirt that is room temperature. Note: Make sure the dirt is moist and not too dry. Record how long it takes the worm to burrow. For the worm to be considered burrowed the posterior end of the worm should be all the way under the soil. If the worms don’t burrow within fifteen minutes, stop that trial and move on.

Step Four:
Do this for all of the different times. (1 minute, 5 minutes, 10 minutes, and 20 minutes.) Note: When the worms are done burrowing put them on the tray and squirt them with water to get the food dye off of them.

Step Six:
Repeat these steps for 10-100% dilution.

The scientists chose this way of exposing the worms because it thoroughly makes sure the worm will be exposed to the food dye. The scientists also chose to dilute the food dye because humans don't normally eat just straight food dye. So if they diluted it, it would simulate human behavior more. The measured outcome of this experiment was to track the worms burrowing time. The scientists measured the data by putting how long it took the worm to burrow in a graph. Some observations recorded were that, for the most part, the longer the worm was in the food dye dilution the more hyperactive the worm got. The scientist also noticed that, for the most part, the higher the percent of food dye there was, the more hyperactive the worm got.

Safety Concerns

Some safety concerns the scientists had to beware of were to always wear safety goggles when doing the experiment. When doing this experiment, if the food dye got in the eyes of someone it could cause harm. Another safety concern is to social distance and always wear masks. With the COVID-19 pandemic happening right now, the scientist did not want to get the COVID virus.

Results

Food dye affects humans and animals in a negative way.[10] Food dyes can be everywhere in foods. The main chemical in food dye is indigotine.[11] If a human becomes hyperactive due to the consumption of food dye, it is affecting the nervous system. Food dye can cause allergies, hyperactivity, learning impairment, irritability, and

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[10] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 16 Feb. 2021.
[11] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 16 Feb. 2021.

aggressiveness.[12] as well as ADD.[13] Some tumor growth and cancer is because of the consumption of food dye. It can also lead to extra calories and fat. One study found that 75% of parents noticed that their children's behavior and attention were better when they took away food dye.[14]

Food dye is mostly used in food. It is important to understand if this environmental agent affects humans and their health. The scientists decided to test earthworms because they have a similar nervous system to humans. Because food dye affects the nervous system's hyperactivity, the scientists hypothesized that the food dye would affect an earthworm's locomotion at a faster speed and affect its burrowing time. In this experiment, the scientists tested food dye on an earthworm's burrowing time. The scientists first made dilutions for 10-100% of food dye dilutions. Then they prepared four different exposure chambers and kept the worms in the chambers for one minute, five minutes, ten minutes, and twenty minutes. Once the time was up, the scientists placed the worm in a cup of dirt that was room temperature. The scientists also made sure that the dirt was moist before they placed the worm in the cup. The scientists recorded how long it took the worm to burrow. They repeated these steps for all the different times the worm was exposed to the food dye dilutions. The scientists always squirted the worm with water when it was done burrowing. They then did this procedure for 10-30% food dye dilutions. The scientist only used 10-30% of food dye dilutions because they ran out of time.

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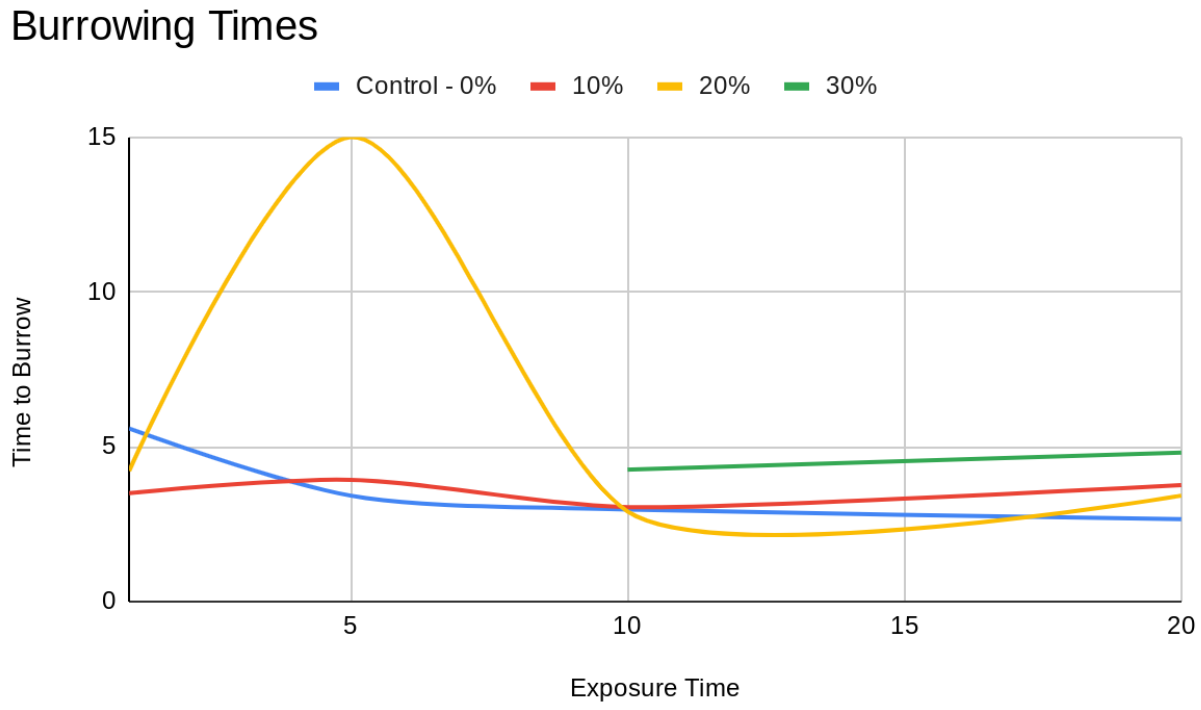
[12] "The Hidden Health Risks of Food Dyes | EatingWell." https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 16 Feb. 2021.
[13] "Where does blue food dye come from? - Scientific American." 30 Jan. 2009, https://www.scientificamerican.com/article/where-does-blue-food-dye/. Accessed 16 Feb. 2021.
[14] "The Hidden Health Risks of Food Dyes | EatingWell." https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 16 Feb. 2021.

There were some trends and patterns in this experiment. The scientists noticed that the data was skewed all the over the place which can be a trend. Sometimes the worm burrowed faster and sometimes it burrowed slower. For the most part the longer the worm was in the exposure chamber and when the dilutions went up, the crazier the worm's locomotion got. This data supports the scientists' hypothesis that if an earthworm was exposed to food dye then it would affect the worm's locomotion at a faster or slower speed and affect its burrowing time. This data however isn't statistically correct.

In this experiment, there were some major limitations during the duration of the experiment. For example, the time the scientist was given was not enough time to finish the full experiment. Also human error can play a role in this. The scientist may have kept a worm in an exposure chamber for a little longer than the said time. They could have also not put enough or too much water or food dye in the dilutions. Also, maybe the scientist should have also used a different way of exposure because of not enough research. The scientists results were also not statistical. Many factors play a role in this.

Total Time to Burrow (Average)				
Exposure Time (Minutes)	**Control - 0%**	**10%**	**20%**	**30%**
1 minute	5.59 minutes	3.50 minutes	4.22 minutes	
5 minutes	3.42 minutes	3.93 minutes	15< minutes	
10 minutes	2.97 minutes	3.05 minutes	2.91 minutes	4.26 minutes
20 minutes	2.66 minutes	3.76 minutes	3.42 minutes	4.81 minutes



Discussion

In this experiment the scientists noticed some trends. One trend they noticed was that the worm burrowed at all different times. The data was very skewed. The data they collected supported their hypothesis, but further information would make it more reliable. The scientists hypothesized that if an earthworm was exposed to food dye then it would affect the worm's locomotion at a faster or slower speed and affect its burrowing time. This hypothesis is to test environmental agents and human health and that is exactly what it did. By exposing the worm to food dye, they would get affected by it. If the worm got affected by food dye, then that means humans would get affected by it too. This is because worms have a similar nervous system to humans.[15] The scientists wanted others to know that food

[15] "Earthworms, Salamanders and Humans: A Pathway to New ...." 30 Apr. 2018, https://ysjournal.com/earthworms-salamanders-and-humans-a-pathway-to-new-discoveries/. Accessed 19 Feb. 2021.

dye is a danger in the world and that people should be aware of that. This may be a small thing but it still affects humans. Once again, there were some limitations that the scientists faced. The scientists had to remember that there is human error that plays a role in the experiment. They may have kept the worm in an exposure chamber too long or maybe had made the wrong dilutions. Also, maybe the scientists should have also used a different way of exposure because of not enough research. The scientists' results were also not statistical. Another limitation is that the time the scientist was given was not enough time to finish the full experiment.

In the experiment, the worm always did what it did for a reason. The worm's reaction of taking a long time to burrow and taking a short time to burrow all happened for a reason. This happened because food dye can make a human's or a worm's nervous system get hyperactive through the consumption of food dye. Since worms breathe through their skin, they were consuming the food dye dilution when they were in the exposure chamber. This caused the food dye to get into the worm's nervous system. The worm can eventually get hyperactive when this happens.[16] When humans consume food dye on a regular basis it gets into their nervous system and makes them hyperactive as well.

This experiment is important to society for many reasons. One reason is because it helps humans to know if food dye affects the nervous system. This is important because the nervous system is a vital part of movement, balance, sensation, thinking, and coordination.[17] Another reason this experiment is important is because it helps humans know if it affects other parts of the body. Some cases of cancer or tumor growth have been linked to food dye consumption. Also, if the food dye does affect humans, it could cause

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[16] "The Hidden Health Risks of Food Dyes | EatingWell." 8 Oct. 2010, https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 21 Feb. 2021.
[17] "Nervous System Problems | Michigan Medicine." https://www.uofmhealth.org/health-library/nersp. Accessed 21 Feb. 2021.

Attention Deficit Disorder (ADD), allergies, learning impairment, irritability, and aggressiveness.[18]

If the scientists had more time to do this experiment, they would do things to further the knowledge on the topic of food dye. One thing they would definitely do is finish the full experiment. Another thing would be to research more on the effects of food dye and other experiments on it. The scientist would also like to test the effect of food dye on different animals. They could also use a different type of way to expose the worm like dropping the dilution around the worm and observing what happens when the worm touches the liquid.

[18] "The Hidden Health Risks of Food Dyes | EatingWell." 8 Oct. 2010, https://www.eatingwell.com/article/16442/the-hidden-health-risks-of-food-dyes/. Accessed 21 Feb. 2021.