Name(s)

Sydney Adcook

Project Number

S2101

Project Title

Silver Nanoparticle Exposure Effect on the Growth of 13 Common Strains of the Human Gut Microbiota

Abstract

Objectives

Many products advertise silver nanoparticles as an immune supplement. The purpose of this experiment was to evaluate the potential toxicity of silver nanoparticles marketed as a dietary supplement on beneficial bacterial strains (known as probiotics) commonly found in the human gut microbiome.

Methods

Bacteria were first cultured in 3 mL Luria broth vials, and were then plated using the streak plate technique on Lactobacilli MRS agar. The agar plates contained a total of 144 trials. Silver nanoparticle dilutions ranging from 500 parts per million to 0 parts per million were calculated and created before inoculation. The measure of the substance's antimicrobial effects were observed through the use of the agar well diffusion assay. Measurements (in mm) on areas of inhibition were taken over a period of six days.

Results

Areas of inhibition formed, thus indicating an antimicrobial effect. It was found that the increase in silver nanoparticle solution concentration correlated with a greater antimicrobial effect. The areas of inhibition for the most concentrated solution, 500 ppm, had an average diameter of 7.3mm, while there was no area of inhibition for the control group. An increase in antimicrobial effect was seen throughout the testing period, as areas of inhibition were only observed after the second day. This increase is most likely due to silver ion (free radical) buildup in the agar.

Conclusions

It was observed that ingesting abnormal amounts of silver nanoparticles would lead to a decrease in bacteria in your gut. Disruptions in this microbiome could lead to imbalances between the two major phylums of gastrointestinal bacteria: the Firmicutes and Bacteroidetes. As a result, the person will be more susceptible to irritable bowel syndrome as well as an increased risk for obesity. In summary, while the antimicrobial properties of silver nanoparticles were observed in vitro, their effectivity depends on the frequency of ingestion. With infrequent or one time- consumption, antimicrobial properties would be nullified by the time needed for the particles to release enough silver ions to have any substantial adverse effect on neighboring probiotic colonies. However, if the supplement is ingested frequently, there are potential adverse effects on not only the stomach microbiome, but surrounding tissues as a result of silver ion buildup. Based on this, it is concluded that the use of dietary silver nanoparticles is likely to be more harmful than beneficial.

Summary Statement

I determined the toxicity of colloidal silver nanoparticle exposure on the beneficial strains of bacteria in the human gastrointestinal microbiome.

Help Received

My science teacher provided many essential materials as well as a classroom to conduct my experiment in.

Name(s)

Benjamin Chang

Project Number

S2102

Project Title

Analyzing Dental Pulp Stem Cell Response to TiO2 ALD and Fused Deposition Modeling on PLA Bioscaffolds

Abstract

Objectives

With the increase in demand for tissue and organ replacement, bioscaffolds are being used to regenerate cells, serving as a foundation for them to regrow. As the biocompatibility of scaffolds is essential to cellular growth, factors that optimize their viability are being studied. Research has shown surface topography of a scaffold is a major factor in determining cellular proliferation and differentiation. In this study, surface topography of the scaffolds was altered by 1) the method of producing the scaffolds and 2) by adding materials onto the scaffold in order to analyze effects in dental pulp stem cell (DPSC) proliferation and differentiation.

Methods

The scaffolds were created with polylactic acid (PLA) using two methods: traditional molding and fused deposition modeling (FDM) with a 3D printer to change the surface topography of the scaffolds. In order to maximize plating efficiency, a thin layer of titanium dioxide (TiO2) was coated onto the scaffolds using atomic layer deposition (ALD) to create a rougher surface environment for the cells, measured by the attachment, proliferation, and differentiation of the DPSCs. Cells were cultured on 3D printed and molded scaffolds as well as with and without the titanium dioxide coating.

Results

The rougher scaffolds were predicted to have greater cell attachment and proliferation, due to greater surface area and physical resistance on the scaffolds. The results showed that the DPSCs were healthy on all of the scaffolds, with greatest biomineralization on the uncoated scaffolds. Initial testing showed TiO2 coating significantly increased cell attachment ($p<0.05$) on the printed scaffolds. However, biomineralization declined between day 28 and 35 for the TiO2-coated scaffolds, suggesting the TiO2 could've had detrimental effects. The ALP, OCN, and DSPP genes were highly expressed in the 3D printed TiO2 scaffold, showing high levels of cellular differentiation.

Conclusions

Novel bioscaffolds have been created using 3D printing and atomic layer deposition that significantly increases the surface roughness of the scaffold. The 3D printed scaffolds were shown to improve cellular attachment and differentiation, highlighting the viability of this promising technology. The TiO2 nanoparticles had positive effects initially, but ultimately had a detrimental impact on the cells, which needs further research to confirm.

Summary Statement

I created new bioscaffolds using FDM 3D printing and titanium dioxide deposition, and found that 3D printing has a significantly positive impact on cellular growth but titanium dioxide has a negative, potentially toxic, impact on cells.

Help Received

I conducted my research at Stony Brook University with supervision from Dr. Miriam Rafailovich, who helped refine my project proposal. The atomic layer deposition was done at a national laboratory, and the scanning electron microscopy of the cells was done by a university technician.

Name(s)

Sydney Choi

Project Number

S2103

Project Title

Don't Be Salty! Testing the Reaction of Plants to Four Chloride Based Chemicals

Abstract

Objectives

The purpose of the project was to find a plant-friendly alternative to road salt (NaCl). Four types of salt were tested: calcium chloride (CaCl2), potassium chloride (KCl), ammonium chloride (NH4Cl), and road salt (NaCl). Dusty miller (Jacobaea maritima) plants were watered with the different salt types.

It was hypothesized that ammonium chloride (NH4Cl) would cause the least damage to the plants tested because it contains nitrogen, an essential plant nutrient.

Methods

The plants were watered with a solution made up of a rough 4:1 ratio of water to salt. Each week the height of the plants was recorded, as well as signs of dehydration in the plants.

Fifteen plants were used in this experiment. Three plants were used for each salt type, and the last three were watered using regular water. The impact of the salt was recorded by measuring the height of the plants. Signs of dehydration, such as wilting of the leaves, were observed. Over the course of several weeks, the data was recorded in a journal. After the data was collected, it was compared and graphed.

Results

The experiment was conducted for six weeks. The plants watered with the ammonium chloride (NH4Cl) and potassium chloride (KCl) shrank in height. The plants watered with the calcium chloride (CaCl2) solution shrank the most out of the four salt types tested. The plants watered with the sodium chloride solution grew the most out of the four salts tested. The plants watered with the NaCl solution did not show signs of dehydration that were as extreme as the other plants. The control plants grew in height. However, the growth was not as dramatic as that of the plants watered with NaCl.

Conclusions

As a result of the experiment, NaCl was shown to do the least damage out of the four chloride-based substances.

In future studies, more replication of the plants would be ideal. Testing different salts on the plants may also be interesting. The purpose of this experiment was to find an alternative to road salt (NaCl) that would cause less damage to the environment.

Summary Statement

The purpose of this project was to find a plant-friendly alternative to road salt (NaCl).

Help Received

Name(s)

Suchitra Dara; Alor Sahoo

Project Number

S2104

Project Title

Biorational Solutions of a Re-emerging Pest, the Western Grapeleaf Skeletonizer

Abstract

Objectives

WGLS has become and increasingly prevalent pest, especially in organic vineyards and backyard wines because of limited availability of pesticides for these situations. The main objective of this study is to test multiple microbial and botanical alternatives in order to find one or more effective non-chemical options to control WGLS. These environmentally-friendly non-chemical alternatives can also be helpful in conventional farms in promoting sustainable crop protection practices. This study will identify options that can be used as a part of integrated pest management program, which strives to find a balance between chemical and non-chemical pest control options in order to find the most environmentally and economically effective pest management.

Methods

Larvae were collected from the infested, untreated vines and maintained in one gallon plastic tubs with screened lids. Fresh, untreated grape leaves were provided daily for 3 days before starting the assay. For each treatment, five 4-5 instar larvae were placed on a grape leaf disc (rinsed in water and dried) in a Petri plate (100 mm dia) with a moist filter paper. Larvae were treated by spraying 1 ml of treatment solution (containing Dyne-Amic, a surfactant, at 0.125% vol/vol). Application rates for commercial formulations were determined based on the label recommendations for 100 gallons of spray volume/acre. Entomopathogenic fungal concentrations were also determined based on the label rates for similar commercial products. Treatments were replicated four times and the assay was repeated twice. Larval mortality was observed daily and dead larvae were removed and incubated separately. Fresh leaf discs were provided as need to the remaining larvae. Data were arcsine-transformed for statistical analysis using Statistix software. Significant means were separated using Tukey's HSD test.

Results

We find that Entrust and M. anisopliae had an average mortality of 100%. B. bassiana had a mortality of 92.5%, Neemix had a mortality of 85%, Agree had a mortality of 81.3%, and Deliver had a mortality of 70%. The untreated control had a mortality of 37.5%. To correct our data for death not a result of a pesticide via Abbott's formula. We still find that Entrust and M. anisopliae cause a 100% mortality. B. bassiana had a corrected mortality of 81.3%, Neemix had a corrected mortality of 78.3%, Agree has a corrected mortality of 73.3%, and Deliver has a corrected mortality of 45%. We find that the California isolates of B. bassiana and M. anisopliae were effective and thus should be developed into commercial formulations to be used against WGLS.

Summary Statement

Our project analyzes the effects of various microbial and botanical products on the western grapeleaf skeletonizer, and we found that 2 California isolates of B. bassiana and M. anisopliae have the potential to be developed as pesticides.

Help Received

Thanks to Dr. Stefan Jaronski, USDA-ARS, Sidney, MT for propagating the entomopathogenic fungal inocula, Mr. Scott Ockey, Certis USA and Mr. Chris Martinez, Manzanita Berry Farms for providing biopesticide samples, and the University of California Cooperative Extension Entomology and Biologicals

Name(s)

Krina Ghadia

Project Number

S2105

Project Title

Running a Bioessay: Sodium Toxicity's Effect on Lactuca sativa Germination

Abstract

Objectives

Determine the concentration of sodium that become toxic Lactuca Sativa seed germination.

Methods

Germinated Lactuca Sativa in petri dishes with varying moles of sodium. Allowed germination to occur for 5 days to view effects on growth.

Results

The embryonic root of the germinated seeds were measured. The 0.175 mole concentration inhibited and ultimately stopped germination overall through the process of sodium toxicity and osmotic effect.

Conclusions

A 0.175 mole solution of sodium was ultimately toxic to the Lactuca sativa seeds in the germination process, meaning that sodium toxicity, which requires a lower concentration to take effect, had a lower impact on the inhibition of growth as compared to the osmotic effect which needs a higher concentration to take effect. This means that Lactuca Sativa can still thrive and be cultivated in areas with high sodium levels as it has a high tolerance to sodium toxicity.

Summary Statement

I determined the concentration of sodium needed for sodium toxicity and the osmotic effect to inhibit Lactuca Sativa germination.

Help Received

I did not receive any help as I designed, executed, and collected the data from my experiments on my own.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Adriana Golden

Project Number

S2106

Project Title

Effects of E-Cigarette Flavor and Nicotine Concentration on Human Alveolar Epithelial Cell Viability

Abstract

Objectives

FDA Commissioner Scott Gottlieb declared the rampant youth nicotine addiction achieved through JUULs, the widely popular e-cigarettes, to be an epidemic, while UCSF researchers have noted with alarm the lack of knowledge about the acute and chronic effects of e-cigarettes on pulmonary function. This experiment explored the true health effects of nicotine concentration and the popular flavorant compounds in JUULs on the viability of human epithelial alveolar (inner lung) cells.

Methods

Human epithelial alveolar lung cells (A549) were exposed for 24 hours to plain cell media, plain vape liquid (50% propylene glycol/50% vegetable glycerin), plain vape liquid with 5%, 3%, and 1% nicotine concentrations, and JUUL e-liquids of Mint and Virginia Tobacco flavors with 5% and 3% nicotine concentrations. The cells were then incubated for 48 hours. A lactate dehydrogenase (LDH) assay (using enzymatic detection to test for cell death) was then conducted on this media to reveal the effects of these different e-cigarette liquids on the cellular viability. Dr. Jeffrey Gotts of UCSF and his lab team provided the cell cultures; the LDH assay was conducted with his lab's equipment.

Results

The experiment s results revealed that e-cigarette liquids with higher concentrations of nicotine cause greater cell death levels in human lung tissue, despite the presence or absence of flavoring. Concerningly, PG/VG, or plain, unflavored vape liquid without nicotine, also caused significant cell death when compared to the 100% media group. ($p = 0.018$) This means that vaping, even with a nicotine-free pod, still has a harmful effect on one s lung tissue. The difference in cell death levels caused by the difference in flavors suggests that tobacco caused 1.48% more cell death than mint did; yet this difference is so slight that it is not statistically significant ($p > .1$). Therefore, nicotine level has a greater impact on cell health than these flavor compounds do. Nevertheless, more research into the correlation of e-cigarette liquid flavorants and cell death is necessary, but in order to be statistically reliable, larger samples would be imperative.

Conclusions

This experiment revealed concerning trends in the ramifications of e-cigarette use on the cellular level; the evidence indicated that higher nicotine concentrations and certain flavor compounds corrode the lung tissue dramatically. As the popularity of e-cigarettes rapidly increases, especially among youth, it is critical to expand our knowledge of the short and long term health effects of these popular devices, as well as to raise awareness for the dangers of nicotine itself which spread far beyond its addictive potential.

Summary Statement

This study determined that e-cigarette liquids with high concentrations of nicotine and tobacco flavorants prompt greater levels of lung cell damage; however, flavorless, nicotine-free vape liquid is also significantly toxic to lung tissue.

Help Received

Carl Ma, a biology teacher at my high school, taught me proper cell culture and sterilization techniques; Dr. Jeffrey Gotts, my mentor from UCSF, provided cell cultures and media. Also, he allowed me use the lactate dehydrogenase assay plate reading machine in his lab, under his supervision.

Name(s)

Sumanth Gurram; David Wu

Project Number

S2107

Project Title

Electromagnetic Fields Inhibit Cancer Proliferation: An Interdisciplinary Approach to Improve Treatment

Abstract

Objectives

We aimed to explore the effects of low-frequency EMFs on selective inhibition of cancer cells, associated biological/molecular responses and cell-death pathways. Our in vitro study serves TWO major purposes: 1. Given the prevalence of cancer deaths worldwide (especially in developing countries), treatment efficacy and affordability must be improved. We hypothesize that EMFs may demonstrate potential for such treatment. 2. Despite being ubiquitous in everyday life and widely debated in public health, EMFs remain one of the most unexplored fields of biological research. We intend to validate the impact of EMFs in biological phenomena and emphasize the need for further scientific exploration.

Methods

Novel EMF-Apparatus: developed two inexpensive solenoids + smartphone-controlled electrical setup for EMF-exposures (60 Hz, 1-2 mT, 12 hr/day, 3-5 days)
Cellular/Molecular Changes: cultured multiple cancer cell lines (HCT116, SH-SY5Y, RAW 264.7) and non-cancer cells (HEK293); conducted MTS Assay post-EMF to quantify reduced cell viability/proliferation; Ca^{2+}/reactive oxygen species (ROS) inhibitors pre-EMF; fluorescent evaluation of Caspase-3 (apoptosis)

Results

2mT EMF induces >90% cell-death in multiple cancers (effective). 1.0-1.25 mT EMF induces ~60% cell-death in HCT116 and no statistically significant non-cancer cell-death (selective). Cancer-cell death localized to EMF-targeted areas. ~30% cancer cell-death mitigated by both Ca^{2+} and ROS inhibition. No statistically significant involvement of Caspase-3 in EMF-based cancer cell-death.

Conclusions

We engineered a novel, low-cost IoT EMF-apparatus and determined that it is selective, localized and effective against various cancers (unprecedented in previous literature). In addition, we have shown that Ca^{2+}/ROS are involved in EMF-based molecular changes, and that EMF-induced cell-death is independent of apoptosis. These exciting findings demonstrate that EMFs have the potential to improve treatment efficacy and affordability. While further testing is required to fully develop EMF-based cancer therapy, an immediate and important takeaway from our current study is that EMFs can have profound biological implications, thus demanding significant attention in modern biological research.

Summary Statement

In our study, we developed a first-of-its-kind EMF-apparatus, discovered novel therapeutic properties of EMFs in cancer and helped validate the need for further EMF-based research in modern biology.

Help Received

(Intel ISEF Form C completed). We thank Dr. Salvesen at SBP Institute for providing resources (cell culture, assays) and training (equipment, safety). All research/plans for executing project were developed independently. We carried out all experiments and data analysis ourselves under appropriate supervision.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Joseph Huitt

Project Number

S2108

Project Title

Honey! Why Can't My Bees Fly? Investigating the Accuracy of Varroa Mite Treatments

Abstract

Objectives

The objective of this study is to see if different Varroa Mite (Varroa Destructor, parasitic mites) treatments that beekeepers are using are effectively killing and containing the mite infestations that are in my hives while keeping them strong for pollination, overwintering, and not contaminating my honey. While combating deformed wing virus and other new bacteria that is in the hive that can kill the bees.

Methods

Tested different chemicals on treating Varroa mites to find the most natural way to treat the mites and keep the bees healthy. Used HopGuard (natural beer hops), Apistan strips, Apiguard, Apivar, and the Varroa Gate to treat the Varroa mites in a natural way on my 100 of 120 hives of bees. The other 20 hives were the control group to compare the treatments. Comparing the toxicities and efficacies of five acaricidal to both the Varroa mites and host bees.

Results

The testing of the Varroa was compared to the control group after the chemicals were applied. There was a tremendous drop of mites in the hives after 14 days but the chemicals were detected in the honey. When using natural HopGuard the first application was 91.11% efficient, the second application (28 days) was 99.95% efficient. The Varroa Gate on the other hand was 96.52% efficient and at 28 days it was 99.97% efficient. The beta acids in HopGuard II cause death to the mites by asphyxiation by penetration of the pest's thin exoskeleton. The Varroa Gate on the front of the hives with the embedded acaricide in the plastic and works like a dogs flea collar.

Conclusions

The Varroa Gate and HopGuard treatments killed only the mites, not the bees. It was 99.95% efficient in killing the mites and Colony Collapse was minimal or eliminated 100%. I found HopGuard used beta plant acids from hop plants and does not harm bees or brood, and leaves no residue in the honey. The Varroa Gate acts almost like a flea collar on a dog and transfers the treatment to the bees as they crawl through the gate and does not leave residue in the honey. My hives were stronger when overwintering and leading into pollination. When using chemicals to treat my bees I found it had neonicotinoides which are found in chemicals the farmers are spraying on their orchards, this is taken back into the hives and causes bee deaths and deformities.

Summary Statement

My project showed how using different Varroa mite treatments affect the bees and how to eliminate them from the hive.

Help Received

My mom worked with me as she is a beekeeper, and I had the University of Maryland Bee Diagnostic Team help with my testing.

Name(s)

Li Meinhold

Project Number

S2109

Project Title

The Effects of UV Radiation on C. elegans Growth Rate as a Model for the Impacts of Interstellar Travel

Abstract

Objectives

My goal was to determine the impacts of UV radiation on C elegans growth rate, as a model for its impacts on C elegans overall genetic health.

Methods

I used C elegans on E coli and agar plates that were exposed to radiation provided by a lamp designed for reptiles. I then time synchronized the worms, and imaged them using a microscope.

Results

The lengths of the worms showed a statistically significant change when comparing the UV exposed populations and the control populations.

Conclusions

This shows that more study is needing into the suitability of C elegans as an interstellar passenger, as well as the effects that such travel could have on these organisms.

Summary Statement

I found that as the radiation dose increased there was a statistically significant impact on the growth rate of C elegans nematodes.

Help Received

I received safety training and information on common laboratory procedures from Dr, Pradeep Joshi in the Neuroscience Research Rnstitute of University of California Santa Barbara. I was also allowed access into Rothman Labs, also at UCSB.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Beatrice Mihalache

Project Number

S2110

Project Title

Effects of Polyethylene Microbeads on Lactuca sativa var. longifolia

Abstract

Objectives

The objective of this study is to examine the effects of microplastics in the soil on plant health and on soil properties.

Methods

A group of lettuce was grown in soil with a 10% concentration of polyethylene microplastics, while a control group was grown in plain soil. After 49 days, the plant height was measured with a ruler, the biomass was weighed with a gram balance, and the root length was measured with a ruler. The water holding capacity of the soils with and without microplastics was also quantified. To visualize whether microplastics were taken in by the lettuce, fluorescent microplastics were added to the soil of another group. After 19 days, these plants were cleaned thoroughly, mashed up, and tested for fluorescent beads.

Results

Results demonstrated that microplastics in the soil increase the water holding capacity by 29%, that plants growing in soil with microplastics grew 17.9% taller than the control plants, and that the differences in dry biomass and root length between the two groups were not statistically significant. The analysis of the lettuce grown with fluorescent microplastics demonstrates that microplastics are carried along with the plant matter even after rinsing thoroughly with water.

Conclusions

This study demonstrates that microplastics do not come off the plant even after plants are thoroughly washed, which is possibly harmful to animal and human plant consumers. This study also demonstrates that microplastics in the soil significantly increase the water holding capacity of the soil and the height of the plants, which are positives for the agriculture business.

Summary Statement

I showed that microplastics in the soil increase the water holding capacity of the soil, that plants grown in soil with microplastics are taller, and that microplastics have a tenacious tendency to adhere to plant matter.

Help Received

Feedback received from Cathy Messenger, teacher & mentor at Los Gatos High School, throughout the entirety of my project. She also helped me develop a method for how to determine whether microplastics were taken in by the plants. All experiment setups, data collection, and data analysis were done by me.

Name(s)

Annalisa More

Project Number

S2111

Project Title

Detection and Removal of Pesticides Residues from Organic and Non-Organic Produce of the Salinas Valley

Abstract

Objectives

To determine if organic produce contains detectable amounts of pesticides, and to determine if there are options to remove pesticides from non-organic produce.

Methods

Organic and non-organic fresh produce grown in the Salinas Valley was obtained from local grocery stores. Strawberries and spinach were chosen because they are major crops grown in this area and require high amounts of pesticides to be grown non-organically. Organic and non-organic produce were soaked in deionized water and pesticide detection was accomplished using a lateral flow assay (NIDS ACE Rapid Pesticide Test, ANP Health, Inc, Newark, Delaware, USA). Different methods of removing pesticides from non-organic produce included rinsing with water, soaking in water of various temperatures and solutions (including a commercially available produce wash). Results were determined qualitatively as positive or negative. All tests were performed in duplicate. Unwashed non-organic produce was used as a positive control, and deionized water was used as a negative control.

Results

A total of five samples of organically grown strawberries and five samples of organically grown spinach were performed in duplicate, for a total of ten assays each. Nine of 10 (90%) organic strawberry samples were found to contain pesticides. Six of 10 (60%) organic spinach samples were found to contain pesticides. Five methods to remove pesticides from non-organic produce from strawberries and spinach were performed. A 30-second water rinse removed pesticide from 50% of strawberry and spinach samples. A 5-minute water soak, vinegar solution soak, and commercial produce wash removed pesticide from 50% of spinach samples, but not from strawberry samples.

Conclusions

Organic produce is popular because of the assumption that it contains no pesticides. However, in my study, pesticides were detected on 90% of samples of organic strawberries and spinach. It is possible that these pesticides are present as a result of water or soil contamination, or from overspray from the aerial application of pesticides. Attempts to remove pesticides from spinach were only partially effective, but was largely unsuccessful from strawberries. This may be due to pesticides being present within the strawberry rather than simply on the surface.

Most organic strawberries and spinach growth in the Salinas Valley contain detectable pesticides. Removing pesticides from non-organic produce is difficult for spinach, and nearly impossible for strawberries.

Summary Statement

My project is basically detecting and removing of pesticides residues from organic and non-organic produce of the Salinas Valley

Help Received

My father had helped purchase supplies and supervised the overall experiment.

Name(s)

Atreyi Mukherjee

Project Number

S2112

Project Title

The Effect of Nicotine Strength and Inactive Material in E-Cigarette Liquid on the Pulse Rate of Lumbriculus variegatus

Abstract

Objectives

The purpose to this project is to test what the effects of different concentrations and varieties of electronic cigarette liquid have on the pulse rate of Lumbriculus variegatus. Research has shown similarities between the development of human epithelial cells and annelid cells. By finding the average pulse rates and toxicity of blackworms in different concentrations of e. cigarette liquid, a correlation between the effects of the liquid on blackworms and on human epithelial cells in developing human lungs will be deduced. 52% of the teenage population in the US used e-cigarettes in the past year, so it is important to test the possibly detrimental effects of e-cigarette usage. The research on e-cigarette liquid focuses on the brain with nicotine, which damages the PFC of the teenage brain. By testing the toxicity of the liquid on blackworms, similar to human epithelial cells, and the effects of inactive ingredients on the blackworms, impacts on human cells can be predicted.

Methods

To start this procedure, the effects of different concentrations of nicotine, 5% and 10%, on the pulse rates were tested by immersing the worms in diluted e-cigarette liquid and then observing the pulse through the translucent body under a dissecting scope. In addition, the effects of ingredients such as propylene glycol (PG) and vegetable glycerin (VG) were recorded with two LD50 tests for the 36mg PG and VG. This determined how toxic these two ingredients were to blackworms and allowed observation of physical effects like choked vessels.

Results

The general trend in the data showed that compared to the control: 0mg VG was 12.7 beats slower, PG was 35.3 beats faster, and 36mg VG was 24.4 beats faster. From the LD50 test: the 36 mg lethal dose of PG is 2% and VG is 2.75%-3%. After exposure to the ingredients, PG, all the blackworms become inflamed and 68% of the 110 in PG had ruptures in their epithelial tissue.

Conclusions

This has a connection to the background research I did on the effect that bronchiolitis obliterans, also connecting to the similarities between human epithelial cells and annelida cells. This is a visual representation of the popcorn lung disease and how it affects the growing lungs of teenagers using e. cigarettes. Therefore, this procedure and data can be used to simulate the effects of e-cigarette liquid on human epithelial lung cells by observing annelida cells that closely simulate them.

Summary Statement

I found that as nicotine strength increases in e. cigarette liquid, blackworms exposed to the liquid reacted with faster pulse, and that propylene glycol caused blisters on blackworms, correlating to the effect of the liquid on human lungs.

Help Received

I researched the background of my topic, designed the experiment, and analyzed the data on my own in my high school's biology lab. My supervisor assisted me by recommending the LD50 data analysis technique.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Samika Swamy

Project Number

S2113

Project Title

CogniGuard: A Novel, Herb-based Treatment for Protection against Neurotoxicity from Lead Pollution

Abstract

Objectives

Institute for Health Metrics and Evaluation (IHME) estimated that in 2016 lead exposure accounted for 540,000 deaths and 13.9 million years of healthy life lost worldwide due to its long-term effects on health. IHME also estimated that in 2016, lead exposure accounted for 63.8% of global burden of idiopathic developmental intellectual disability. Exposure to lead in environment can occur through various anthropogenic sources. Lead toxicity in the body can cause serious health disorders, especially neurological, and can even result in death. It is therefore necessary to treat lead-induced neurotoxicity to counteract its detrimental effects on the human body. The goal of this project is to design and build an environmentally-friendly, low-cost, herb-based treatment to provide protection against neurotoxicity from lead.

Methods

Part1: Protection against neurotoxicity (CogniGuard) was created as a pill from 4 herb sources - Withania Somnifera, Curcuma Longa, Moringa Oleifera, and Ginkgo Biloba, including pre-treatment with papaya enzyme. 3 versions of CogniGuard were created with varying ratios of the herbs. Part2: Testing was performed with Drosophila Melanogaster as model organism. The 3 tests performed were Locomotive Behavior Test, Response to Non-Volatile Chemicals Test, and Morphological Changes Test. Plain media was used as control.

Results

After effects of lead in D. Melanogaster and improvements by usage of CogniGuard treatment were demonstrated. All CogniGuard Versions (1, 2, and 3) proved to be effective in repairing functions of D. Melanogaster that had been exposed to lead toxicity. For Locomotive Behavior, all CogniGuard versions exceeded the goal of 25% increase in number of flies reaching the target line. In Response to Non-Volatile Chemicals, lead inhibited the ability of the flies to travel towards the sucrose end - all CogniGuard versions exceeded goal of 25% increase in the distance traveled by the flies. In Morphological Changes test, lead induced effects were witnessed on the body of larva and decreased its growth, delaying the development of the fly. Maximum improvement and results closest to control group was again witnessed with CogniGuard1, followed by CogniGuard3, and finally, CogniGuard2.

Conclusions

CogniGuard Version 1 which contained W. Somnifera, C. Longa, G. Biloba, and M. Oleifera in equal parts was the leader in improving neurological abilities of D. Melanogaster that were exposed to lead neurotoxicity.

Summary Statement

I created an environmentally friendly, low-cost, herb-based treatment for protection against neurotoxicity induced by environmental lead exposure.

Help Received

My STEM teacher Ms. Fallon, offered guidance and support through review and feedback, and I conducted my experiment at my school lab.

Name(s)

Korbyn Turney

Project Number

S2114

Project Title

Effects of Silver Nanoparticles on Mortality Rates of Freshwater Microorganisms at the Arcata Marsh

Abstract

Objectives

Utilizing 12 different concentrations of silver nanoparticles in Arcata Marsh water, determine and measure the effects of silver nanoparticles on the mortality rates of 10 freshwater microorganisms.

Methods

Sciencebuddies.org provided calculations for creating 5 low concentrations of silver nanoparticles. I adapted the calculations to create 6 high concentrations of silver nanoparticles with 550 PPM colloidal silver. Daily observations were made to determine the effects of silver nanoparticles on Daphnia, Cyclops, rotifer, coleps, chlamydomonas, nematode, and diatoms populations over 3 weeks. An additional procedure developed during the experiment when hypotrichs, gastrotrichs, and vorticella had noticeable population changes. For those microorganisms, fresh Arcata Marsh samples were collected on three Sundays and observations were made to count the organisms in the fresh samples, the control, and in all the silver nanoparticle concentrations to determine the effects of silver nanoparticle environments on hypotrichs, gastrotrichs, and vorticella.

Results

In concentrations lower than 1 microgram/ml, mortality rates of diatoms, chlamydomonas, and nematodes increased slightly compared to those in the control. Rotifer and coleps mortality rates decreased in all concentrations of silver nanoparticles but stayed stable in the control. Daphnia and cyclops were most sensitive to silver nanoparticles with daphnia exterminated in concentrations at and above 2.5 micrograms/ml, and cyclops eradicated in concentrations at and above 5 micrograms/ml. Gastrotrich populations increased in the middle range concentrations, hypotrich populations increased in the higher concentrations to as high as 670 organisms in a 1 ml sample, and vorticella populations increased in the middle range of the low, and the middle range of the high concentrations.

Conclusions

This experiment supports that lower concentrations of silver nanoparticles entering the environment through landfill run-off will have little effect on the microorganism mortality rates in freshwater watersheds. Concentrations of silver nanoparticles introduced into the environment through situations including industrial waste will be detrimental to the equilibrium of the microorganisms in freshwater watersheds which will then affect the entire ecosystem and food webs that it supports.

Summary Statement

Low concentrations of nanosilver introduced into freshwater watersheds have little effect on microorganisms while high concentrations akin to industrial waste skew populations of microorganisms which affect whole ecosystems.

Help Received

Perrin Turney helped to identify the freshwater microorganisms. Perrin Turney's input aided in developing the second procedure of the project to evaluate three microorganisms added to the study. Greta Turney helped take photos through the microscope and helped to collect samples and supplies.