CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Noah N. Alderson

Project Number

S1501

Project Title

Microbial Fuel Cell and the Effects that Different Substrates Have on Electrical Output

Abstract

Objectives/Goals

This experiment is based upon the premise that, bacteria, if in an anaerobic environment, can create a small electrical charge that is somewhat insignificant. However, if different solutions are used as nutrients for the bacteria to feed on then the electrical charge will either decrease or increase. This experiment intends to prove that a corn-syrup based solution will produce a higher amount of electricity than the controlled sugar-and-paper mix. The economic aspects of this experiment will be a factor, as this experiment is also purposed to prove that a successful microbial fuel cell can be created using obtainable items.

Methods/Materials

Compression fitting, Acrylic storage containers , Adhesive, like acrylic cement, Aluminum foil, Nickel epoxy or other conductive epoxy, Digital multi-meter with leads, Petri dish, Agar, Fruit Juice, Corn Syrup, Table Sugar, Aquarium air pump with tubing, Resistors 220-ohm.

Results

The substrate with the high amount of sugar produced the most electricity. The controlled substrate produced an average amount of electricity, given that it would not produce a large amount. The fruit juice substrate performed, but only generated a miniscule amount of electricity. The corn syrup substrate destroyed its equipment and was unable to be used.

Conclusions/Discussion

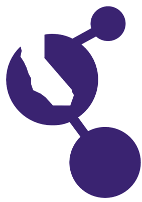
The hypothesis aligned with the results, however, only in the results of the high sugar substrate, with the others falling subpar (beneath the control). The results, though disappointing (as in the case with the corn syrup), can be accepted because this experiment tested the feasibility of using such substrates, so these superficially failed substrates still fulfilled their purpose by proving that they cannot work.

Summary Statement

This project tested the plausibility of using different substrates in a microbial fuel cell to increase electrical output to a practical level.

Help Received

Mother helped strip wires.



CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Clarice B. Arcia

Project Number
S1502

Project Title
Air Pollution: What We Should Wear

Abstract

Objectives/Goals
My objective was to find out how well do the clothes we wear protect us from the pollutants in the air by testing commonly worn fabrics in compleatly diffrent locations,with Petri dishes to see the bacteria and the pollutants that were absorbed by the fabric.

Methods/Materials
Useing 4 diffrent fabrics, 100% cotton, 100% ployester, mixed 12% nylon 88% polyester, thick 100% cotton denim, I cut five 10cm squares out of each fabric makeing twenty squares. I then disenfected each square with bleach then placed into a high heat dryer untill compleatly dry. After, I got five tightly sealed plastic bags, placeing 1 of each fabric in the bags makeing 5 sets.I then numbered the bags, sets 1-5. Aftert I got twenty petri dishes and twenty rubber bands. i grabbed each set and placed the fabric on top of the dish and tightly rapped the rubber band around the it,and placed the sets back in their tightly sealed plastic bags. Set #1, was made my control group to ensure a fair test, by leaveing them in their bags in dark light. Set #2 was placed in my home. Set#3 was placed outside of my house in a small neiborhood. Set #4 was placed in my garage. And set #5, was placed on the corner of a busy street. Each set was left in there location for 24 hours. After they were incubated for 48 hours. After the incubation I was able to see all the bacteria that had went each through fabric.

Results
Denim showed to be the most protective with the least amount of bacteria. Next was the polyester, then came the mixed fabric and lastly can the cotton with the most bacteria.

Conclusions/Discussion
Denim turned out to be the most protective, my theroy is because of the density of the material and how tightly the fibers are weaved together. Next came polyester. Then was the mixed and lastly and certianly the worst was cotton. my theroy for the cotton is because of how loosely the fibers were woven, makeing the fabric able to strech un like the denim, so the bacterias can go straight through the material. but all in all clothes protect us from pollutants no matter what, with out clothes are skin would be bare and we wouldnt have a barrier to prevent the pollutants from comeing directly onto are skin, increasing are chances of getting sick, astama, cancer and or death. so when it comes to being smart in what you where in areas that are exposed to a lot of pollutants, you may want to where denim.

Summary Statement
How well do the clothes we where on a day to day basis protect us from pollutants and bacteria in the air.

Help Received
Used lab equptment from reedly collage under supervision of Dr. Elizando;

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Masih A. Babagoli

Project Number

S1503

Project Title

Effects of Three Essential Oils on the Growth of the Fungus Alternaria solani

Abstract

Objectives/Goals

The objective is to see if the natural essential oils of Carum copticom, Zataria multiflora, and Satureja hortensis are able to inhibit the growth of the fungus Alternaria solani, which would allow them to replace the chemical fungicides being used against the early blight of tomato disease, caused by Alternaria solani fungus.

Methods/Materials

200 and 400ppm of each essential oil were dissolved in acetone and added to separate 100ml flasks holding the liquid PDA for the experimental groups. For the control groups, no essential oil was added. 32 Petri-dishes were labeled, and the liquid PDA of each treatment was poured into corresponding Petri-dishes. 5mm pieces of the cultivated fungus were placed on the PDA of the 32 Petri-dishes. Four replications were prepared for each treatment.

Results

The 200ppm of the Carum copticom treatment had no growth at all in 3 of 4 replications. In the 4th replication, the 5mm primary inoculum grew only 1mm. The 400ppm of Carum copticom had no growth at all in any of the 4 replications. The 200ppm of Zataria multiflora treatment grew 55.6% of the corresponding control group. The growth of the fungus under 400ppm of Zataria multiflora grew 45.6% of its corresponding control group. The 200ppm of Satureja hortensis treatment had almost no growth inhibition, with its growth being 95.47% of the corresponding control group. Ironically, 400ppm of the Satureja hortensis treatment grew 150.6% of the corresponding control group.

Conclusions/Discussion

Since Carum copticom was able to stop 99.5% of the growth in 200ppm and 100% of the growth in 400 ppm of the Alternaria solani fungus, it can potentially replace the chemical fungicides being used against the early blight of tomato disease caused by this fungus. This would be greatly beneficial since it is an all-natural way to battle something which is currently being fought against with chemical fungicides. Some of these fungicides have been deemed as skin irritants, toxic if inhaled, and even deadly. Chlorothalonil, one of the fungicides previously used, was given to two species of frogs in a study in the expected environmental concentration, resulting in 87% mortality in 24 hours. These essential oils practically have no side effects. Tomatoes are a major part of the human diet, grown throughout the world, and largely susceptible to the Alternaria solani fungus and therefore the early blight of tomato disease.

Summary Statement

Three essential oils were tested to see if they would inhibit the growth of the Alternaria solani fungus and thus able to replace the chemical fungicides used against the early blight of tomato disease, the disease caused by this fungus.

Help Received

used laboratory of Azad University, Isfahan/Khorasgan Branch in Isfahan, Iran; supervised by Prof. Dr. Ebrahim Behdad; two lab assistants helped teach some of the procedures so that I could do them on my own during the research; English teacher Mrs. Tawny Billings helped edit the format of the research

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Conner R. Bennett

Project Number

S1504

Project Title

Does Hippopotamus Skin Secretion Prevent E. coli Bacteria Growth and Protect the Skin from Harmful Sun Light?

Abstract

Objectives/Goals

The hippopotamus (Hippopotamus amphibius) produces a skin secretion containing pigments that are thought to prevent infection and protect the skin from harmful UV spectra. This study seeks to collect enough volume to test un-synthesized hippo skin secretion#s resistance to E. coli bacteria, measure the pH, and compare the UV-vis spectra to human sunscreen products. Research indicates, hippo skin secretion should resist E. coli bacteria, be alkaline, and absorb at least 50% of the harmful UVB light.

Methods/Materials

Collaborating with the San Francisco Zoo, skin secretion samples were collected using tissue paper from the hippo. E. coli strain K-12 MG1655 bacteria were grown in the presence of raw skin secretion at different concentrations. A pH meter and UV-vis spectrophotometer was used to test the samples. The number of colonies was counted and the number of colony-forming units was calculated.

Results

This study succeeded in collecting enough hippopotamus skin secretion volume to complete the experiment. The data shows that the skin secretion concentrations tested did not block E. coli bacteria growth. But, a 10% skin secretion concentration reduced the number of E. coli bacteria colony-forming unit#s by 23.2% relative to the control. Over 21 days, the pH shifted from 9.5 to 8.5 at the same time the color changed from pink to red, like a halochromic substance. The hippopotamus skin secretion absorbed light in the burning range, but two human sunscreen products absorbed more light.

Conclusions/Discussion

The data supported the hypothesis that hippo skin secretion would inhibit bacteria growth and be alkaline. The data did not support the hypothesis that skin secretion would absorb at least 50% of the harmful UVB light. This is only third scientific study that both collects samples and documents properties of hippopotamus skin secretion. The results indicate that additional research regarding hippo skin secretion preventing infection from microbes and protecting the skin from harmful UVB light is needed.

Summary Statement

This study seeks to collect enough volume of hippopotamus skin secretion to test un-synthesized samples resistance to E. coli (Escherichia coli) bacteria, measure the pH, and compare the UV-vis spectra to human sunscreen products.

Help Received

Mr. Eric Teasley, Doctoral Student at Stanford University provided access to a lab and advice during the project. Also, San Francisco Zoo Staff Mr. Jim Nappi (Curator of Hoofstock and Marsupials) and Ms. Julie McGilvray (full-time Hippopotamus Keeper) gathered the hippopotamus skin secretion samples.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Kyle Correia; Ariane Nazemi

Project Number
S1505

Project Title
The Mechanics of Life

Abstract

Objectives/Goals
This project is a cluster of experiments aimed at creating an apparatus to successfully and efficiently grow enegy-producing algae. In order to do this, tests were done to discover what would be the best form factor and amenities for the algae. We chose to perform our experiments on a strain called Dunaliella tertiolecta, which is known for its high lipid yield. This lipid can then be turned into fuel.

Methods/Materials
For the medium solution, we chose to test the necessity of a medium called F/2. F/2 medium is a cocktail of nutrients specifically designed for Dunaliella tertiolecta. the test consisted of two sets of beakers with two beakers in each set. The control held a 1:10 ratio of algae to seawater, while the variable had the same ratio, with 2mL of F/2 medium added. these beakers were set under grow lights and daily spectrophotometer readings were taken at the 760 nm spectrum. These readings were then inputted into a hemocytometer/spectrophotometer linear regression to get cell counts.
Alongside the medium test, it was tested to see whether or not bubbling would be valuable to include in the apparatus. A beaker with identical contents to the variable of the medium test, as well as a micro-bubbler, was placed under grow lights, with spectrophotometer readings taken regularly.
The final component of the apparatus ended up being more of a research project than an experiment. We tried to find out what spectrum of light algae grows best in, and found lights to accommodate that.

Results
The medium test showed that the algae with the medium grew to have three times the cell count of the control for only 2mL of the cocktail. This made it necessary for the medium to be included due to its sheer boost in speed. The bubbling experiment revealed interesting results, for it had ended up killing the algae within through excess turbulence. We discovered that our type of algae prefers the natural light spectrum the sun emits. Prototype one incorporated all of the knowledge we gathered through the project, but gave us unexpected results: it was creating such turbulent conditions for the algae, that they were getting killed. This, coupled with the fact that the prototype was not as energy efficient as possible, lead us to create our second prototype.

Conclusions/Discussion
The second prototype is in its final phases of testing, and solved the turbulence issue by instituting an Archemedes screw that promotes a current.

Summary Statement
Trying to create a energy-producing algae culturing apparatus using the least amount of energy and resources.

Help Received
Dr. Jay Vavra provided facilities, materials, and guidance; Rick Bizzoco and Elliott Weiss provided algae strains and advice

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Gabrielle A. Evey

Project Number

S1506

Project Title

Bothersome Bacteria Encountered in Restaurant Restrooms: Which Surface Is Dirtiest?

Abstract

Objectives/Goals

This science project was created to promote awareness of how much, or how little, bacteria is on common bathroom surfaces. The hypothesis was stated as, if the toilet seat, faucet knobs, and exit door handle are swabbed from a women's public restaurant restroom, then the exit door handle will have the highest amount of bacterial growth in 72 hours.

Methods/Materials

A total of 20 restaurants were swabbed in this project. Before swabbing, nutrient agar was boiled and poured into sterile petri dishes with the use of sterile rubber gloves. Restrooms were swabbed focusing on 3 areas: the toilet seat, faucet knobs, and exit door handle. After swabbing, the bacteria was placed onto the petri dish, sealed with masking tape, and placed into the incubator. The visible amounts of growth were placed into three categories: excessive, moderate, and trace after 24, 48, and 72 hours. Excessive contained large colonies, many colonies, or swarming bacteria with colonies. Moderate contained a number of medium-sized colonies. Trace contained 3-10 small colonies.

Results

After 72 hours: 75% of toilet seats contained excessive growth and 25% with moderate. 30% of faucet knobs contained excessive growth, 30% with moderate, and 40% with trace. 30% of exit door handles contained excessive growth, 30% with moderate, and 40% with trace. Percentages reflect 72 hours of incubation at 98 degrees Fahrenheit.

Conclusions/Discussion

This data did not support the hypothesis. The data shows that toilet seats grew the most bacteria in 72 hours, rather than the exit handles. Strains of E. coli and staph aureus were found in the petri dishes, so in an additional small study, generic antibacterial soap was placed onto the infected petri dishes to see if the soap killed the bacteria. No bacteria was visible on the parts of the petri dishes containing soap, supporting that soap reduces the growth of these bacteria. The spread of infection by these bacteria can be reduced by hand washing with soap and water after touching these common restroom surfaces.

Summary Statement

Toilets seats, faucet knobs, and exit door handles were swabbed to see which grew the most bacteria.

Help Received

Mother drove to collect bacteria and purchased materials; Used lab equipment at Edwards AFB Clinic under the supervision of Gabe Bannerman.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Melissa R. Fagan

Project Number

S1507

Project Title

Creation of Alginate Microparticles as a Novel Drug Delivery Vehicle

Abstract

Objectives/Goals

Bacterial resistance is a growing issue in the modern world. Silver is an antimicrobial that does not have the same issues with resistance associated with antibiotics. The success of silver depends upon a dose that maximizes antimicrobial activity but minimizes toxicity.

Methods/Materials

Alginate microparticles, encapsulating silver antiseptics, were engineered through emulsification and internal gelation with the objective of minimizing the downsides of rapid silver deactivation and toxicity. Microparticles were synthesized with and without the encapsulation of silver sulfadiazine (SSD) and tested for their ability to inhibit the growth of Staphylococcus epidermidis, a substitute for the pathogenic Staphylococcus aureus. Research was also conducted to determine stability, size and density of the microparticles.

Results

Results demonstrated that the alginate microparticles had an average size of between 1-10µm and were stable with regard to density, particle size and appearance. Antimicrobial testing at 24 and 48 hours showed that alginate microparticles containing SSD produced significantly increased antimicrobial activity when compared to alginate microparticles alone ($p<0.001$). Results also demonstrated a significant increase in the zone of inhibition of alginate microparticles containing SSD from 24 to 48 hours ($p<0.05$ vs. SSD alone). The release continued through 96 hours ($p<0.001$ vs. SSD alone). Further experimentation was conducted to investigate release of SSD from alginate microparticles. Pre-treatment with alginate-lyase showed a decrease in anti-microbial activity from 24 to 48 hours ($p<0.05$).

Conclusions/Discussion

These findings illustrate the ability of alginate to provide a continual release of encapsulated agents. Additionally, results gathered from pre-treatment with alginate-lyase suggest that alginate-lyase breaks down the microparticles causing immediate release of SSD. This continual release technology, therefore, has the potential to negate many of the current issues with silver-based treatments.

Summary Statement

My project provides a means of helping patients with chronic wounds fight off bacterial infection by encapsulating antimicrobials into a micro-sized alginate shell, thereby minimizing costs and pain associated with frequent dressing changes

Help Received

Used lab equipment (chemicals, glassware etc.) from school under the supervision of Dr. Willoughby as required by school policy.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Nicholas E. Fifield

Project Number

S1508

Project Title

What Is the Dirtiest Place in the House?

Abstract

Objectives/Goals

I wanted to find the dirtiest place in my house. I chose 9 places in my house. I bought petri dishes and agar to grow samples of what actually lives at these places. By growing these samples and recording their size, I found the dirtiest place.

Methods/Materials

Method: Melt agar in microwave. Pour into petri dishes and number each dish. Cool overnight. Rinse swab with distilled water. Swab chosen areas. Swab into petri dish by making Z formation without contaminating petri dish. Place petri dishes into plastic bags under a hear lamp to replicate a homemade incubator. Each day take out all petri dishes and record their growth. Also clean bags of excess condensation. Continue for seven days.

Materials: 4 agar bottles, 40 petri dishes, 20 swabs/20 loops, gallon of distilled water, microwave, 3 gallon plastic bags, heat lamp, thermometer, clock, paper towels, measuring pies, pen, paper, gloves, kitchen mitts, and camera.

Results

I made measuring pies for the petri dishes so I could compare and contrast the growth each day. In agar bottle D all of the samples did not grow because of the agar bottle not being melted enough. I had 9 places that I recorded and a 10th petri dish that was considered my control sample. The phone had no growth. The toilet seat, TV remote, and door knob had only 5% growth. The toothbrush had 3 positive results but not a tremendous amount of growth. The computer keyboard had 2 positives but a large mold growth and possible contamination. The kitchen counter had 3 positive results with multiple types of microorganisms. Inside the microwave there were 3 positive results two of which took 25% of the petri dish and the same bacteria. The corner of the room had the most growth and variety of microorganism in each dish.

Conclusions/Discussion

The corner of the room had the most variety and biggest size of all the samples. It rejected my hypothesis that the doorknob was dirtiest. The toothbrush had 3 positive results and did not have quite as big growth as the corner of the room but the toothbrush grew exactly where I swabbed. The microwave had 2 positive results, no significant growth. The toothbrush and microwave both seemed to have bacteria growth only. If I had to do the experiment all over i would have made sure all of my problems including not boiling the agar in bottle D enough were fixed. Contamination was also a small problem in that it could change the results.

Summary Statement

My project is about what item in your house has the most organisms on it that the human eyes can not see.

Help Received

My Mom and Dad helped me with the experiment, including taking pictures and assisting me during the process.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Kyle Groves; Michael Wintermantel

Project Number

S1509

Project Title

Preservation of Plant Viruses Using a Food Dehydrator

Abstract

Objectives/Goals

We wanted to determine if a food dehydrator can be used to preserve plant viruses for use in future experiments and for transport of virus samples from remote areas of the world.

Methods/Materials

Plant leaves, each infected with one of 7 different plant viruses, were dried in a food dehydrator. Dried leaf tissue was used to inoculate test plants with the viruses along with controlled inoculations using fresh infected tissue to see if dehydrated viruses were still infectious. Viral RNA was extracted from plants and used in reverse transcription-polymerase chain reaction (RT-PCR) to determine if the viruses could be used for molecular biology studies after dehydration.

Results

Most plants inoculated with dehydrated virus-infected plant tissue showed disease symptoms comparable to those inoculated using fresh virus infected tissue in replicated experiments. There were two exceptions, which produced only 75% of control infection rates when dehydrated tissue was used for inoculation. We extracted total nucleic acid and ran RT-PCR on two viruses, and found both amplified equally well when purified from dehydrated or fresh infected plant tissue.

Conclusions/Discussion

Using a food dehydrator for virus preservation results in minimal loss of virus infectivity compared to infected tissue collected from live plants, and is a very good method for storing viruses long-term. The method would be inexpensive and useful for transporting viruses from remote areas of the world that have limited availability or funding for high tech equipment such as a freeze dryer.

Summary Statement

We wanted to determine if a food dehydrator can be used to preserve plant viruses for use in future experiments and for transport of virus samples from remote areas of the world.

Help Received

We used equipment and supplies in the Plant Virology Lab at the USDA-ARS in Salinas, CA and received training and supervision from Dr. Bill Wintermantel and Ms. Laura Hladky.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Ryan Hsu

Project Number

S1510

Project Title

A Unique Approach in DNA Based Identification of Airborne Fungal Population in the Sacramento Area

Abstract

Objectives/Goals

My objective is to identify and document the airborne fungi present in the Sacramento area. I believe this can be achieved by a combination of a new method of collection, culturing, and identification.

Methods/Materials

Airborne spores were collected in the Fall and Winter months using an Ionic Spore Trap. Collected spores were cultured in growth medium. Well separated individual colonies with sizable mycelium were collected, frozen in liquid nitrogen and stored at -70°C. Fungal DNA were extracted from the mycelium and thereafter the nucleotide sequence of the fungal 18S rRNA were determined by Polymerase Chain Reaction (PCR) and nucleotide sequencing. The identity of each fungus was determined by matching the nucleotide sequence with the GenBank database.

Results

This project demonstrated an effective method of collecting and culturing ascospores which has not been previously achievable. In this study, approximately 15% of the collected spores were viable. Notably 60% of the viable spores were ascospores. Specifically, Lecythophora, Phaeosphaeria rousseliana, Phaeosphaeria CC52, Phaeosphaeria caricicola, Coprinellus xanthothrix, and Trametes versicolor were shown to be present in the Sacramento area.

Conclusions/Discussion

This work has successfully demonstrated that viable airborne ascospores can be collected for microbiological culture and identified by DNA sequence analysis. A detailed database of airborne ascospores can be established using this method. In addition, a parallel study conducted in the laboratory has demonstrated that PD170 (Phaeosphaeria) reacts with sera samples from patients with fungal allergies. Future studies identifying these fungal allergens at the molecular level will improve medical therapies.

Summary Statement

This project identifies and documents the airborne fungi species present in the Sacramento area by a combination of a new method of collection, culturing, and DNA identification.

Help Received

Used lab equipment at the University of California, Davis under the supervision of Professor Patrick Leung

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Mohamed A. Ibrahim

Project Number

S1511

Project Title

Don't Forget to Deodorize

Abstract

Objectives/Goals

Deodorant and antiperspirant deodorant are two substances that are applied to the body to decrease body odor. This study examined the relationship of the amount of bacteria, Staphylococcus Epidermidis, with two different types of deodorant.

Methods/Materials

Bacteria were incubated in Petri dish that included agar with nothing (dependent), deodorant, or antiperspirant on top. Data was recorded every six hours for a total period of 72 hours. The experiment was done 10 times for every variable, 30 in total.

Results

The results suggest that deodorant decreases the amount of bacteria while antiperspirant increases the amount. This experiment can lead to new inventions such as ones that kill bacteria instead of covering up their smell.

Conclusions/Discussion

Due to the fact that these products are popular and widely used, it is crucial to know and understand their harmful effects. People use antiperspirant believing that it will serve them better than deodorant, not knowing the negative aspects. My experiment unravels the myth of antiperspirant and proves the advantage of deodorant. Manufacturers should attempt to produce healthier products that kill bacteria and last longer duration.

Summary Statement

My project is about the effects of deodorant and antiperspirant on bacteria.

Help Received

No one helped me with my project

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Grace Jin Li

Project Number

S1512

Project Title

The Effect of Geobacteraceae on the Power Generation of a Microbial Fuel Cell

Abstract

Objectives/Goals

What is the effect of different sources of geobacteraceae on the power generation of a microbial fuel cell? Is one of the products of the microbial fuel cell pure, drinkable water?

Methods/Materials

Three microbial fuel cells with identical cathode and anode chambers, electrodes, and salt bridges were built. The secondary (biological) treatment sample was collected from the wastewater plant, and the ground food household wastewater sample was mixed. The wastewater samples and control were poured into individual anode bottles, and sealed airtight. Each cathode bottle was filled with a saltwater conductive solution. The external circuit was connected to the resistor (multi-meter) and the millivolt readings were recorded twice daily, for thirty days.

Results

1. Wastewater sample resulted in the highest power production.
2. Ground food sample resulted in the lowest power production.
3. One of the products of the microbial fuel cell is clean, drinkable water.
4. SODIS and UV light are not as effective as microbial fuel cell and boiling are at disinfecting water.

Conclusions/Discussion

Wastewater sample resulted in the highest power production because it contains the most potential bacteria. Benthic mud sample resulted in average power production because the bacteria were moved out of its natural environment. Ground food sample resulted in the lowest power production because it is the most unnatural of the three and had to generate its own bacteria. Microorganisms added to the secondary (biological) treatment wastewater at the treatment plant, generated the highest reading of 152.45 millivolts. This is only 10.16 percent of a 1.5 volt AA battery output. Ground food naturally produced nearly half the secondary treatment millivolt level. The data demonstrates that a microbial fuel cell can be used to harvest electricity from ground food and secondary (biological) treatment wastewater. One of the products of the microbial fuel cell is clean drinkable water. It is effective in disinfecting water. Boiling the water kills bacteria because in this process, water reaches the high temperature that burst the cell walls and deform the bacteria, SODIS never reaches these high temperatures. It does, however, kill a good amount of bacteria by mutating the DNA of the bacteria. It kills more bacteria in six hours than exposing the water to UV light bulb for thirty-six hours does.

Summary Statement

To determine the effects of different sources of geobacteraceae on the power generation of a microbial fuel cell and to determine if one of the products of the microbial fuel cell is pure, drinkable water?

Help Received

My parents drove me to the stores and bought the supplies for me.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Olivia K. Maglieri

Project Number

S1513

Project Title

Investigating the Bacteria Contamination Levels on Different Coins Exposed to Various Environments

Abstract

Objectives/Goals

The purpose of my experiment was to test various metals on blocking bacteria. Coins consist mainly of copper, zinc, and nickel. I intended to test which metals inhibited bacteria from growing in various environments. The environments that I tested included lake water, soil, and student's hands.

Methods/Materials

The method that I followed in my experiment consisted of placing coins in the different environments for 24 hours. I tested the coins in two different ways. I swabbed coins onto petri dishes, and I placed coins directly onto the agar. After a 48 hour period, I was able to determine the amount of bacteria that was either repelled or had grown. Using a centimeter grid placed on the agar dish, I was able to count the bacteria colonies following a mathematical process. Then I compared the collected data to determine the most effective metal.

Results

My results showed that the pennies in the hand environment which were swabbed had the least amount of bacteria growth.

Conclusions/Discussion

I was able to determine that different metals in coins limit bacteria growth. I had thought the student's hands would have the most bacteria, but I found that the lake water had the most bacteria. The properties of metal limit bacteria growth and therefore metal surfaces are used in hospitals and medical labs.

Summary Statement

Testing metals in different environments against bacteria growth.

Help Received

Mr. Whittington checked final drafts.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Kathleen R. Maguire

Project Number

S1514

Project Title

Bacterial Biofilms Are Influenced by Beta-Lactam Antibiotics

Abstract

Objectives/Goals

The purpose of this study was to analyze the effects of beta-lactam antibiotics on otitis media pathogens.

Methods/Materials

Non-typeable Haemophilus influenzae (NTHi) and Streptococcus pneumoniae (SP) bacterial strains were incubated for 24 and 96 hours in the presence of selected concentrations of amoxicillin, cefuroxime and ampicillin. At sub-lethal concentrations of the antibiotics NTHi exhibited increased biofilm formation (both 24 and 96 hour biofilms) as assessed using a crystal violet biofilm assay. Scanning Electron Microscopy (SEM) and confocal Laser Scanning Microscopy (cLSM) were used to confirm the results of the crystal violet assay.

Results

Although beta-lactam antibiotics are known to be bactericidal, it was hypothesized that sub-lethal concentrations may enhance biofilm growth. At sub-lethal concentrations of the antibiotics NTHi exhibited increased biofilm formation (both 24 and 96 hour biofilms). These antibiotic concentrations were deemed maximum stimulatory concentrations (MSCs). At these MSCs, biofilm formation increased while bacterial count decreased. SP biofilm formation was inhibited by all of the antibiotics at the concentrations tested.

Conclusions/Discussion

This research, while focusing on otitis media, is applicable to all biofilm infections. Many biofilm infections are chronic so it is possible that other biofilm bacteria will be influenced by sub-lethal concentrations of antibiotics. Results from testing other biofilm bacteria and antibiotic combinations using these methods may help explain the causes of chronic biofilm infections.

Summary Statement

Beta-lactam antibiotics can stimulate biofilm formation.

Help Received

Used lab equipment at House Research Institute under the supervision of Dr. Paul Webster

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Nicholas R. Mayner

Project Number

S1515

Project Title

The Shocking Truth: Enhancing Algae Based Biofuel through Low Level Electrostimulation

Abstract

Objectives/Goals

The objective of my project was to increase the efficiency of algae based bio fuel production through the use of low level electro-stimulation.

Methods/Materials

I seeded four identical tanks with the same amount of algae. I then applied zero volts, one half volt, one volt, or one and one half volts to each tank. The tanks were allowed to grow for seven days. I calculated the relative increase in weight of the algae growth by comparing the weights to my control group (zero volts) weight.

Results

Electro-stimulation on average increased the growth rate of algae 19%.

Conclusions/Discussion

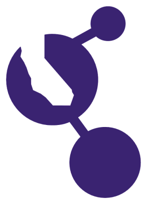
Low level electro-stimulation can be used to increase algae production by an average of 19%. This is is an inexpensive and simple technique that can be used to enhance photobioreactors production efficiency, significantly lowering the per gallon cost of algae based bio fuels.

Summary Statement

I tested how low level electro-stimulation affects the growth rate algae, and I found I could increase the growth rate of algae by an average 19%.

Help Received

My mentor, Nicholas Eckelberry, who works at Origin Oil reviewed my work and provided guidance. My chemistry teacher, Olin Bausback, allowed me to use his precision scale to weigh the algae. My father guided me in the creation of a circuit board which delivered the appropriate voltages.



CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Andy S. Meyers

Project Number

S1517

Project Title

Algae: The Living Oil Factory

Abstract

Objectives/Goals

The objective is to determine whether a pressure cooker or microwave is more effective in breaking open the cell membranes of algae to release the oil to produce biofuel.

Methods/Materials

The algal strain Tetraselmis chuii was cultured in two closed photobioreactors. The algae was harvested using the filtering and settling methods. About 120 ml of algae was harvested for testing. Samples were heated for approximately 30 seconds in a microwave and for ten minutes in a pressure cooker. The processed samples were mixed with light petroleum distillate and centrifuged. The top layers were separated and analyzed.

Materials:
Culturing: photobioreactor, algae in medium (Tetraselmis chuii, distilled water,
salt, algae nutrient, iron and manganese
Harvesting - Filtering method:coffee filters and buckets
Settling method:graduated cylinders and pans
Extracting: microwave, pressure cooker, beakers,vials, metal container for pressure cooker

Results

1) .5 ml of oil were derived from each of the pressure cooker and microwave samples representing 10% and 7.7% of wet biomass, respectively.
2) Observations of processed algae under a microscope and the centrifuged layers suggested that the cell membranes had been ruptured in all samples.

Conclusions/Discussion

1. Culturing: No issues were incurred in culturing. Since culturing requires monitoring light, salt, pH, nutrients, and water and air temperature, it can be difficult. The Tetraselmis chuii is a hearty strain.
2. Harvesting: The filtering method could not be used because of the small size of the Tetraselmis chuii. The settling method worked but was time and space consuming.
3. Extracting:
a. Both microwave and pressure cooker tests were successful in rupturing the cell and releasing the oil.
b. Both the microwave and pressure cooker method can be used with #wet# algae which eliminates the step of drying.
c. The pressure cooker was easier to use. The microwave was difficult to monitor as algae started to boil

Summary Statement

I researched extraction methods to obtain oil from algae as a potential source for a biofuel

Help Received

Dr. Steve Lyon explained harvesting methods; Used lab equipment at Cal Poly Pomona under the supervision of Professor Joelle Opotowski and Grad Student Diane Engler; Mother helped me prepare my board

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Marine Minasyan

Project Number

S1518

Project Title

The Effects of Second Hand Smoke on Bacteria

Abstract

Objectives/Goals

The objective of this project is to determine whether second hand smoke has any effect on bacteria such as E.Coli and S.Epidermidis.

Methods/Materials

Three different types of cigarette smokes were used to expose bacteria to second hand smoke in a chamber built by student. A suction vacuum was used to penetrate the second hand smoke inside the chambers. For the first part of the experiment the bacteria were cultured in an incubator, exposed to second hand smoke and later gram stained to be looked at under the microscope. The second set of bacteria were inoculated on the petri dishes and exposed to second hand smoke right away. Results were observed and recorded.

Results

The bacteria that were exposed to second hand smoke after being cultured had their cell walls broken and discoloration had occurred. The ultra light second hand smoke had the most effects. The second set which was not incubated, however exposed to second hand smoke right away, did not grow at all, no matter what type of smoke they were exposed to. The bacteria in the control group did as expected.

Conclusions/Discussion

In conclusion my hypothesis was proven correct which stated that if bacteria were exposed to second hand smoke, their growth would be inhibited and the bacteria which were first grown then exposed would have their cell walls broken down. These findings show that the toxicity of second hand smoke can even kill bacteria. Ultra light second hand smoke was most successful in breaking down cell walls between light and regular. However in the second set all three types of second hand smoke absolutely inhibited the growth of bacteria.

Summary Statement

The effects of second hand smoke on bacteria.

Help Received

Mrs. Ramirez Delacruz for guidance and mental support.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Bhavesh H. Patel

Project Number

S1519

Project Title

The Effect of Brominated Vegetable Oil on Yeast Populations

Abstract

Objectives/Goals

Can bakers yeast of the species Saccharomyces cerevisiae respire, metabolize, and reproduce without an adverse effect in the presence of the amount of brominated vegetable oil (BVO) that is used in commercial drinks as an emulsifier, such as Orange Gatorade? If not, then it suggests that an alternative emulsifier should be used.

Methods/Materials

Three individual yeast cultures were made: Active-Dry + Sucrose, Active-Dry + Gatorade Orange, Active-Dry + Gatorade Mango Extremo. I altered the type of nutrient given to the yeast cells (sucrose, Gatorade Orange, or Gatorade Mango Extremo - sucrose being the control; Orange has BVO, Mango lacks BVO) to test my hypothesis. An iodine-stained drop from each of the four cultures at 0 hours, 24 hours, 48 hours, 72 hours, and 96 hours was transferred into the wells of three KOVA Glasstic Slides, ruled in ½ mm squares. The number of cells in eight squares for each time period were counted under a microscope at 400x.

Results

My data showed yeast cells exposed to the sucrose and Gatorade Mango Extremo started with about 200 cells and nearly doubled after 24 hours, then gradually began to decline until the population was virtually dead. Conversely, cells exposed to Gatorade Orange did not show this doubling period and only grew slightly, adding only about 30 cells to the original population size after 24 hours. After this, the population declined more rapidly than the other two yeast populations.

Conclusions/Discussion

My objective was attained: the brominated vegetable oil in the commercial drink had an adverse effect on the yeast cells, in that stunted growth occurred compared to the populations not exposed to BVO (sucrose and Mango), due to the death of several cells from the increased amounts of bromine. This suggests that a natural emulsifier, such as those obtained from cellulose or Ester gum, should be used in place of BVO in commercial drinks. Also, the populations died off, rather than plateaued, because of the accumulation of ethanol, which becomes toxic to the yeast at increased levels, from anaerobic fermentation that the cells undergo.

Summary Statement

This project is aimed to test if the brominated vegetable oil used in commercial drinks as an emulsifier is harmful to yeast cells, and therefore possibly harmful to humans, which may give reason to use an alternative natural emulsifier.

Help Received

Recieved micrographs of slides at Anaheim Regional Medical Center from Dr. Welsh; Recieved advice on examining yeast cells under the microscope from Professor Suzanne Sandmeyer UCI School of Medicine via email; borrowed microscope from Paul Hunt, teacher of Biology at Villa Park High School.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Roberto P. Pimienta

Project Number

S1520

Project Title

Measuring the Toxicity of ZnO Nanoparticles in Pseudomonas stutzeri

Abstract

Objectives/Goals

This project aimed to determine that ZnO nanoparticles are antibacterial agents through measuring their toxicity in Pseudomonas stuzeri. This is a denitrifying bacterium commonly found in the rizhosphere and groundwater (Lulacat et al, 2006). The relationship between Zn2+ ions and number of viable cells was measured. By exposing the nanoparticles to ambient laboratory lighting, it was also observed whether it has an effect on the concentration of Zn2+ ions and the toxicity of ZnO nanoparticles.

Methods/Materials

In order to test the variables for this experiment, five sterile culture tubes containing different combinations of nanoparticles, bicarbonate solution, cell pellets, and exposure to light were created. Viable cells and concentration of Zn2+ ions were measured during a 90-minute interval. Viable cell counts were obtained using serial dilutions and media plating, and the concentration of Zn2+ was measured utilizing an Induced Coupled Plasma (ICP) spectrometer.

Results

ZnO nanoparticles are toxic to P.stuzeri. When nanoparticles are not exposed to light, they are more bactericidal. Light also appears to promote more release of Zn2+ ions from ZnO nanoparticles.

Conclusions/Discussion

There may be an unidentified toxic mechanism which acts under dark conditions. The research of Adams and collaborators (2006) suggests that an alternate toxic mechanism may exist in ZnO nanoparticles under dark conditions.

Summary Statement

This project determined that zinc oxide nanoparticles are toxic to Pseduomonas stutzeri, and it also observed how different conditions of light affect the nanoparticle's toxicity.

Help Received

Under the supervision of a graduate student, I worked in Stanford's Environmental Earth System Science Department. My research is not the same research the graduate student conducts.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Andre Poon; Jenny Vuong

Project Number

S1521

Project Title

Plants vs. Bacteria: Comparing the Antibacterial Properties of Different Plants

Abstract

Objectives/Goals

To test the antibacterial properties in plants. We are comparing herbaceous plants lower than 25 cm and woody plants to see which kind has a hire bacterial properties.

Methods/Materials

We will be collecting herbaceous plant samples such as ginkgo, oxalis and other woody plants, mashed up the plant to make a plant solution. Then mix the bacteria in with the solution and then spread it onto Petri dishes. We tested many different techniques. For example, we mixed the bacteria into the plant solution first, then spread it on the petri dishes. Another technique we use was to spread the plant solution first and then the bacteria. Our purpose is to see if it makes a difference in the result that we will obtain.
The materials that we need are plant samples, agar plates, inoculation loop, gloves, mortal and pestle, test tube, centrifuge tubes, ethanol, distill water, hot plate, beakers of various sizes, gloves.

Results

In the first trial, we did not boiled the plant when we make the plant solution. We dip the bacteria collected from our teeth into the plant solution then spread it on the petri dishes. According to the data we have collected, there was a 70% reduction of the bacteria growth with the oxalis plant solution. Other plant such as ginkgo also had a 50% decrease in bacterial growth. In the second set of trials, we boiled the plant this time before making the plant solution. The result were less effective than the plant that we did not boil, however the results still shows that there was a decrease in bacterial growth. The density of the bacteria colonies in the petri dishes with plant solution was less than in out control.

Conclusions/Discussion

From the 2 sets of trial that we have done, we can see that the plants we have collected does not kill any bacteria, however it does inhibits the growth of the bacteria. It seems to be more effective if we did not boil the plants. Additionally, when we did the second set of trials. It seem to be more effective when we mix the bacteria in the plant solution first before putting it on the petri dish versus spreading the bacteria first then spread the bacteria on. Our thought on that is because when we mixed in the bacteria with the plant solution, it allow the proteins in the plant to break into the cell wall while it was still dividing. However it does not work on already existing colonies of bacteria.

Summary Statement

To test the antibacterial properties in herbaceous plants versus woody plants.

Help Received

Our teacher provided some most of the materials that we did not have access to, except the plants that we have collected ourselves.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
Adam J. Protter

Project Number
S1522

Project Title
Phytopharmaceutical Assay of Antimicrobial Properties of Piper (L.) Genus with a Novel MIC Protocol for Oil Extracts

Abstract

Objectives/Goals
Misuse of antibiotics has increased the number of drug-resistant germs. Though there is some evidence supporting the use of herbal medicines as antibiotics, scientific studies in this field are in their infancy. Researchers are now looking at indigenous medicine. The present study was designed to evaluate the antimicrobial properties of ethanol and CO2 extracts of various Piper genus plants.

Methods/Materials
Aqueous, ethanol, and supercritical CO2 crude extracts of Piper genus were screened for antimicrobial activity against Staphylococcus Epidermis (Gram positive), and E. coli (Gram negative), using the disk diffusion method of Kirby-Bauer where sterile plates were prepared and spread with cultures against which the antibacterial activity is to be evaluated. The antimicrobial activity of each extract was expressed in terms of the mean diameter of zone of inhibition (ZOI) produced by each extract at the end of the incubation period. All experiments were performed in triplicate. Minimum Inhibitory Concentration of the extracts was determined by a novel serial dilution agar method.

Results
In the disk diffusion trials against E.coli, P. Nigrum oil exhibited significant antimicrobial activity yielding a ZOI 33% larger than that of Amoxicillin. P, betel oil yielded a ZOI comparable to that of Amoxicillin. The supercritical CO2 Piper aduncum exhibited intermediate effects against E.coli with a ZOI of 9mm, 42% smaller than that of Amoxicillin. On the gram positive trials using Staphylococcus epidermidis, there were several active compounds. T he CO2 extract of Piper aduncum exhibited significant activity against S.epidermidis yielding a zone of inhibition of 20.6mm, 6.7% larger than that of Vancomycin, the last resort antibiotic. The oil of Piper betel gave a ZOI of 8.5mm, 44% smaller than that of Vancomycin.

Conclusions/Discussion
This investigation reveals the antimicrobial nature of extracts of the Piper genus. Extracts of ethanol, aqueous, and CO2 were used for extraction of antimicrobial metabolites. Out of the extracts used Piper betel was most effective against Gram-negative and Piper aduncum was most effective against Gram-positive.

Summary Statement
This study evaluated the antimicrobial properties of ethanol and CO2 extracts of various Piper genus plants.

Help Received
Parents purchased materials and edited and proofread board.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Dennis J. Shim

Project Number

S1523

Project Title

Microsatellite Distribution Analysis in Various Bacterial Genomes Using Mathematica

Abstract

Objectives/Goals

This project analyzes various genomes to explore possible relationships between different bacteria based on microsatellite distribution. The objective of this research is to design and implement an algorithm into Mathematica to count the number of microsatellites in various genomes and subsequently examine distinctive patterns and characteristics found between and in bacterial families.

Methods/Materials

The genomes of different bacterial species were found in the NCBI database. An algorithm that could read these genomes in and count the number of microsatellites was designed and subsequently implemented into Mathematica. These results were plotted to find distinctive patterns, and the k-values, or slopes, were compared between species. The most frequently occurring microsatellites were also analyzed between species.

Results

It was found that there was an exponential correlation when the algorithm's output was plotted based upon rank of frequency versus the number of microsatellites detected. After linear regression was applied to the log graphs of the plots, the graphs of microsatellite length four showed the best correlation. In six species belonging to the family Enterobacteriaceae, the k-values fell within the range of 0.011 to 0.014, whereas the k-values for six species of the family Clostridiaceae were in the range of 0.025 to 0.030. It was also observed that many of the top ten most frequently observed microsatellite sequences were shared by various bacterial species of the same family.

Conclusions/Discussion

The data showed that the k-values of the species belonging to the same bacterial family stayed within a small range, and that range varied with the family. In addition, many of the most frequently observed microsatellites of a species were found to appear in many other genomes of species of the same family. Thus, the range of k-values and most frequently occurring microsatellites were found to be characteristics of species within a bacterial family. Therefore, microsatellite distribution can be used as a potential tool to differentiate bacterial species by family.

Summary Statement

This study identified two distinctive characteristics related to microsatellites that can be used as potential tools in differentiation of bacterial families.

Help Received

Ms. Lisa Fox helped review my paper; Dr. James Li advised my algorithm design and implementation.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Charulata Sinha

Project Number

S1524

Project Title

Development of Bacterial Cross-Resistance to Repeated Use of Mouthwash

Abstract

Objectives/Goals

My objectives are to determine if oral bacteria will develop cross resistance to other mouthwashes and to antibiotics with repeated use of mouthwash and whether the resistant bacteria can be eliminated or reduced by discontinuing mouthwash use.

Methods/Materials

The Minimum Inhibitory Concentration (MIC) and the Minimum Bactericidal Concentration (MBC) of the oral bacteria S. Gordonii was determined for four mouthwashes and antibiotic: Listerine, Natural Dentist, Rite Aid, Periogard, and tetracycline (antibiotic). The bacteria were then passaged 18 times: grown in mouthwash at a concentration one less than the MIC value. Resistance was measured by MIC and MBC values of the passaged bacteria, and growth kinetics was determined from turbidimetry measurements. The first set of passages was followed by 18 passages in normal nutrient and the MIC of the double passaged bacteria was determined.

Results

Self-resistance and cross-resistance to mouthwash and antibiotic was seen in the bacteria grown in all the mouthwashes. The growth curves of the passaged bacteria showed the bacterial strain grown in chlorhexidine did not replicate as efficiently as other bacterial strains. Passages in the normal nutrient restored the antimicrobial sensitivity for bacteria grown in all the mouthwashes except for chlorhexidine.

Conclusions/Discussion

Repeated passages of mouthwash confer self and cross resistance in S. Gordonii. In three of the mouthwashes the sensitivity of the native S. Gordonii could be regained by repeated passage in normal nutrient.

Summary Statement

Study of bacterial self and cross resistance to anti-microbials and the fitness of the resistant bacteria.

Help Received

Used lab equipment in Professor Kelly Doran's lab at San Diego State University. Consulted with undergraduate and graduate students in Prof. Doran' s lab.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Jack Takahashi; Andrew Tsai

Project Number

S1525

Project Title

A Novel Study of the Adaptation of Pseudomonas putida S12 to a Polystyrene Rich Environment

Abstract

Objectives/Goals

Due to the presence of styrene as an industrial pollutant and its toxic and carcinogenic properties, the ability to biodegrade styrene is greatly desirable in the modern world. Even more advantageous is the ability to degrade polysyrene - which makes up Styrofoam and most plasticware. As plastic cups continually take up more and more volume in landfills, waste management resorts to incineration of polystyrene, which releases pollutants and toxins. A bioremedial process of degrading styrene and polystyrene is thus a crucial research area as landfills continue to grow.
This experiment approaches the problem of styrene and polystyrene degradation using Pseudomonas putida S12, a common soil-based bacteria.

Methods/Materials

Colonies of the bacteria were grown in a carbon-restrictive environment. No nutrients were provided to the bacteria other than liquid styrene monomer, small molecular weight polystyrene, agarose, and M9 minimal media salts. Growth on styrene was observed in three conditions: absorbed into an agarose gel with M9 salts, on plates enriched with BHI, and in liquid M9 minimal media. Growth on polystyrene was observed in liquid M9 media with 2500 Dalton polystyrene.

Results

The results of this experiment show that P. putida S12 can utilize styrene as a sole carbon and energy source for growth comparable to that on glucose; however, the strain cannot utilize polystyrene for growth, although it forms a unique complex with polystyrene creating turbidity, an important discovery with implications in hypothetical polystyrene-degrading bacteria. In parallel, luciferase bioluminescence was studied in P. putida in the hopes of creating a bioluminescent strain for better growth measurement in the future. EMS, a random chemical mutagen, is also under study for future experiments toward a polystyrene-degrading P. putida strain.

Conclusions/Discussion

The ability of P. putida S12 to utilize styrene as a sole carbon and energy source in its liquid form suggest that bacteria could be used for the bioremediation of styrene, and the study of P. putida's interaction with polystyrene contributes to future polystyrene bioremediation studies.

Summary Statement

We studied the effectiveness of using soil bacteria to make styrofoam and its components biodegradable.

Help Received

Used lab equipment at Stanford University under the supervision of Drs. Contag and Hardy.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Erika R. Witt

Project Number

S1526

Project Title

Determining Which Antibiotic Is Most Likely to Prevent Resistance by Effectively Killing Bacteria

Abstract

Objectives/Goals

In the past, bacterial infections were deadly, but today they can be treated with antibiotics. Bacteria can mutate and become resistant to the antibiotics used to treat them, and these strains can be lethal. The purpose of my experiment was to find the antibiotic most likely to kill and least likely to leave inhibited bacteria, reducing the chance of mutation and resistance.

Methods/Materials

Three antibiotics were tested against Escherichia coli bacteria; Cefazolin, Ofloxacin and Gentamicin. Test tubes containing bacteria and media with seven different concentrations of each antibiotic were incubated and monitored for growth. The concentrations without visible growth were then sub-cultured to determine which concentrations only inhibited the bacteria (Mean Inhibitory Concentration, [MIC]), and which concentrations killed them (Mean Bactericidal Concentration [MBC]). I monitored the growth of the bacteria to see if there was a difference between the MIC and the MBC of each antibiotic.The fewest dilutions between the two concentrations showed which antibiotic killed most effectively, without permitting time for bacteria to mutate.

Results

The antibiotic Cefazolin had no identifiable MBC. Ofloxacin had three dilutions between the MIC and the MIC, and Gentamicin's MIC was the same as its MBC

Conclusions/Discussion

In conclusion, Gentamicin was the best antibiotic for treating E. coli because the MIC was the same as its MBC, and therefore left no chance for inhibited bacteria to become resistant. In contrast Ofloxacin had a range of dilutions between the MIC and MBC, potentially enabling it to continue growing and select for resistance. Cefazolin never reached an MBC, meaning it cannot kill bacteria at a concentration tested, and therefore leaves a greater chance for bacteria to continue growing and develop resistance.

Summary Statement

My project focused on determining which antibiotic was most effective and most likely to prevent the development of resistant bacteria.

Help Received

My father, an infectious disease doctor, helped me obtain materials and supervised my techniques and the safety of the project.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Francis C. Yang

Project Number

S1527

Project Title

Investigation of the Antibacterial Activity of Artemisia californica

Abstract

Objectives/Goals

To test the anti-bacterial activities of the sagebrush Artemisia californica, and if true, to determine whether the agent behind such activity is a small molecule or protein.

Methods/Materials

Materials
Artemisia californica sagebrush
Tissue Tearor Model 985370 (BIOSPEC PRODUCTS INC.)
phosphate buffered saline (PBS) (GIBCO 14190)
Beckman Coulter, Allegra X-15R centrifuge
Beckman Coulter, Avanti J-20XP centrifuge, JA-20 rotor
Pierce BCA protein assay kit
Molecular Device, SPECTRAmax340PC
E. coli DH5alpha
LB media
37 Degree C Incubator
GraphPad Prism5
Procedure
-A.californica leaves are collected from a local park,broken by a tissue tearor, and extract are made sucessive centrifugations.
-Bacteria are grown in LB medium and growth rate is measured by following the optical density at 600 nanometers.
-To determine whether protein play a role, two methods were used to eliminate proteins; protease treatment and heat treatment.

Results

In the pilot study, bacterial growth inhibition was observed in wells with the extract greater than 350 micrograms. Bacterial inhibition was also observed even when the aliquot was subjected to heat and protease treatment.

Conclusions/Discussion

The sagebrush Artemisia californica has anti-bacterial activity, and is caused by either a small molecule or heat/protease resistant small peptide.

Summary Statement

This project confirmed the anti-bacterial nature of the sage Artemisia californica, and found the agent behind the activity is either a small molecule or a heat/protease resistant small peptide.

Help Received

Used lab equipment at Allergan under the supervision of Dr. Rong Yang

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

David M. Zimmerman

Project Number

S1528

Project Title

Stress-Induced Mutagenesis and Evolution of Competitive Fitness in Shewanella: Applications for Microbial Fuel Cells

Abstract

Objectives/Goals

Bacteria of the genus Shewanella can respire a wide variety of solid-state electron acceptors; they can serve as biocatalysts in microbial fuel cells (MFCs) and as agents for bioremediation of toxic chemicals. To optimize their utility for these applications, it is first necessary to understand the mechanisms that facilitate evolution under conditions of environmental stress, such as nutrient limitation. Some microorganisms including E. coli are known to acquire mutations during long-term stationary phase which confer an ability to outcompete younger cells; this trait is called a growth advantage in stationary phase (GASP) phenotype. My objective was to characterize the effects of extended starvation on the long-term evolution of Shewanella spp. ANA-3 and MR-7 by assaying for changes in mutation frequency and strength of GASP phenotype expression with variable periods of nutrient-limited aging.

Methods/Materials

Str. were differentially marked with mutations conferring resistance to different antibiotics and aged in batch culture for 30 days; samples were frozen every 10 days. Co-culture competitions were performed in which aged cells were inoculated as 1000-fold minorities into overnight cultures of oppositely marked 1-day-old cells; viable counts were monitored over 12 days by serial dilution with plating on marker-selective media. Finally, unmarked 1- and 10-day-old cultures of both spp. were titered and spread on solid media appended with rifampicin, and resistant colonies were enumerated.

Results

All aged str. expressed GASP phenotypes in competition. For both spp., the log ratio of aged to unaged cells in co-culture after 12 days was significantly higher ($p < 0.05$) for 20- and 30-day-old populations than for 1-day-old controls. 10-day-old cultures of both ANA-3 and MR-7 demonstrated significantly elevated rates of spontaneous mutation ($p < 0.05$ and $p < 0.01$, respectively) relative to 1-day-old cells.

Conclusions/Discussion

These results suggest that nutrient limitation during long-term stationary phase may cause a degree of DNA damage sufficient to induce the SOS response, which is known to cause preferential recruitment of low fidelity DNA polymerases that increase the global mutation rate, potentially accelerating the acquisition of beneficial GASP alleles. This finding is of particular importance given the relationship between competitive fitness and capacity for current-production in an MFC.

Summary Statement

I assayed for changes in the relative fitness and mutation frequency of Shewanella spp. with varying periods of starvation, toward the development of specific strategies for optimizing their utility as biocatalysts in microbial fuel cells.

Help Received

Used molecular biology facilities at USC under the supervision of Dr. Steven Finkel, from whom I received technical guidance.

CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Neera Shah; Nehaly Shah

Project Number

S1599

Project Title

Saving Citrus Trees: Serological Detection of Bacteria Associated with Citrus Greening Disease, Year 2

Abstract

Objectives/Goals

Huanglongbing (HLB) is a devastating disease that has endangered the citrus industries around the world including Florida since 2005. It is associated with an unculturable bacterium, Candidatus Liberibacter asiaticus (LAS), and is spread by Diaphorina citri. The vector has been present in southern California since 2008 and HLB was detected in a backyard citrus tree in Hacienda Heights on March 30, 2012. Early detection is critical for protection of California citrus industry. This project is aimed at raising antibodies against select LAS surface proteins using recombinant DNA technology to aid in development of rapid high throughput serological detection methods.

Methods/Materials

Based on in-silico analysis two putative LAS surface proteins, lepB and yajC, were selected for the study. The two gene fragments were amplified by PCR of DNA of infected plants from Florida and cloned in a bacterial expression plasmid vector, pET101D/TOPO (Invitrogen), and used for transforming Top10 Escherichia coli cells. Plasmid DNA from positive clones confirmed by sequencing were used to transform the expression host, E. coli BL21 (DE3). The bacteria were grown to log phase and the expression was induced with IPTG. Total protein extracts were analyzed by Western blotting for detection of polyhistidine tag at the carboxy terminal of recombinant proteins. The expressed proteins were purified by affinity chromatography using Ni-NTA agarose, and dialyzed. The purified protein was used to raise antibodies in chickens. Test bleeds were tested for their specificity of reaction to the cognate antigens by Western blotting.

Results

Several clones with correct sequence of the entire gene, followed by V5 tag and polyhistidine tag, were identified and used for expression. Expressed protein from large scale expression and purification was tested for purity based on PAGE analysis, and the specificity was confirmed by Western blotting. The antibodies raised in chicken were able to detect the cognate antigen at up to 1:160,000 dilution.

Conclusions/Discussion

HLB has destroyed citrus industries around the world, and has not yet been effectively managed. Early detection is vital for management of the disease. The immunological method of detection is a useful alternate technique to complement the currently used PCR testing methods. The antibodies developed in this project need to be tested against live samples in the field in Florida.

Summary Statement

Recombinant DNA technology was used to develop reagents required for development of early detection of huanglongbing, a devastating citrus disease currently threatening California's citrus industry.

Help Received

The research was conducted at the USDA Citrus Germplasm Repository under supervision of Dr. Manjunath Keremane. Dr. Richard Lee provided facilities. My parents helped for transportation and preparation of board.