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## **ENVIRONMENTAL AND BIOLOGICAL SCIENCES**

### **Using NIR Spectroscopy to Non-destructively Study the Nutrient Content of Eggs**

The purpose of this experiment was to determine if near-infrared spectroscopy could be used to measure egg nutrient content, and to see if nutrients in a hen are feed affects the nutrients of the eggs laid. Using an ASD Quality Spec Pro Near-Infrared Spectrometer, I scanned eggs from hens that had been fed two different diets. Next, I sent the eggs to the USDA ARS poultry lab in Athens, Georgia, for protein and moisture analysis. These lab results showed that the moisture and protein contents didn't change. The spectra also showed that the moisture and protein contents didn't change. This indicated that NIR spectroscopy can be used to measure the nutrient content of eggs. The spectra also showed peaks at the wavelengths that correspond with fat. This indicated that the nutrients in a hen's feed affects the nutrients in the eggs laid. This is the first report of using near-infrared spectroscopy to non-destructively measure the nutrient content of eggs.

### **Bacteria in the Beauty**

Bacteria can live on and in mascara tubes. Several mascara tubes were tested for bacteria to see how much bacteria is collected after each use. Mascara is used everyday for many women across the world, yet many women don't realize how much bacteria they are putting near their eye everyday and the consequences of this cosmetic substance. This study suggests that the more often the mascara was used, the more bacteria grew.

### **Silicate Fertilization of *Thalassiosira pseudonana* Phytoplankton in High Nutrient Low Chlorophyll Areas of the Ocean**

The carbon cycle has been greatly affected by the emissions of carbon dioxide into the atmosphere. Although carbon dioxide is natural, humans have polluted the cycle in many ways. The increase in carbon dioxide can lead to devastating results like global warming. Tiny phytoplankton in the ocean like the diatom *Thalassiosira pseudonana*, accounts for a large percent of the carbon dioxide uptake in the carbon cycle. However, some areas in the ocean, called High Nutrient Low Chlorophyll areas, are lacking large populations of these diatoms. Experiments have been done to see if silicate fertilization can help to increase the number of the diatoms in these areas, therefore, increasing the uptake of carbon dioxide and helping to stop global warming. Test tubes were set up with silicate additions and tested once a day for several days, then once, several days later. The results of the experiment were found to significantly increase the diatom population in the test tubes.

## **Effects of Curcumin on Malignant Melanoma and Normal Melanocytes**

Melanoma, a rare and lethal form of skin cancer, is caused by a mutation in a melanocyte. Curcumin, the active ingredient in the Asian spice Turmeric, is known to bind cellular proteins that regulate many characteristics of cancer, including increased proliferation and the avoidance of apoptosis. However, the truly unique attribute of curcumin is its low toxicity to normal cells. Several variations (analogues) of curcumin that were synthesized have been proven effective against breast cancer, while the other analogues of curcumin had little to no effect. It is hypothesized that the same analogues that were successful in breast cancer will also be successful in melanoma, and the analogues that were not very effective in breast cancer will have little effect on melanoma. The previously successful analogues are also predicted to be more effective than the parent compound curcumin. It is also hypothesized that curcumin and its analogs will be relatively nontoxic to the normal melanocytes. Human malignant melanoma cells were treated separately with curcumin and 7 analogs of curcumin. Cells were cultured and treated in a 96-well plate. Curcumin and 7 analogues were dissolved in a DMSO solution and were tested at 6 doses. An MTT assay, measuring live cells, was performed after 24, 48 and 72 hours of treatment. After the assay, the dish was placed in a plate reader to calculate optical density, in order to compare treatments. The EC50 (Effective Concentration 50%) was calculated by nonlinear regression using GraphPad Prism Software. The results of these experiments demonstrate curcumin and 4 of its analogues tested exhibited antiproliferative activity in melanoma, similar to that previously shown in breast cancer cells. Though Analog 8 was the most effective on the melanoma cells, just as in breast cancer it, Analog 7 maintained low toxicity on melanocytes and stopped proliferation in melanoma.

## **Effects of Iron Deficiency on Reproduction of *Acartia tonsa***

Recent interest in solving global warming has revealed that the ocean absorbs a considerable amount of carbon dioxide. This is largely due to the grazing of zooplankton on phytoplankton and the production of fecal pellets, transporting the carbon to the deep ocean. The discovery of an iron deficiency in large parts of the oceans has led to many questions regarding the efficiency of carbon cycling between the air and the ocean. This study explored the effect of iron deficiency on the reproduction of zooplankton. To test this, iron sufficient and iron deficient *Thalassiosira oceanica* phytoplankton cells were fed to *Acartia tonsa* copepods and its effects on ingestion rates, fecundity, egg viability, and egg size of the copepods measured. The results show that egg production rates as well as hatching rates are significantly lower in copepods fed with iron deficient food and egg sizes larger under those conditions. Phytoplankton cell counts indicate that the iron deficient diet was ingested at a slightly lower rate per copepod than normal. Based on the results, iron deficiency does limit the reproduction of copepods; therefore, likely negatively affecting the zooplankton population and further decreasing the extent of carbon transport from the surface of the ocean.

## **Ozonation to Enhance Control of Escherichia coli Contamination of Fresh Produce**

Escherichia coli have continually plagued the produce industry. Escherichia coli have hazardous and potentially deadly effects on people if ingested. In order to remove E. coli from fresh produce, companies use sodium hypochlorite to deactivate it. Sodium hypochlorite, however, also presents potentially dangerous effects to humans. The goal of the project overall was to reduce sodium hypochlorite demand on the cleaning of fresh produce by introducing ozone, as an additional contingent of the decontamination process. To test this, carrots were infected with E. coli K-12 by placing them in a container of water and E. coli for twenty-four hours. After twenty-four hours the carrots were placed into treatments of water, ozonated water, sodium hypochlorite solution, and ozonated sodium hypochlorite solution. Preliminary data indicated both ozone and sodium hypochlorite have potential to reduce E. coli infestations. Further tests were conducted to determine if ozonation in combination with sodium hypochlorite treatment could result in a treatment process requiring less sodium hypochlorite. An effective process was found that reduced sodium hypochlorite demand to 1/2 the federal cap. In conclusion the results show that using ozone in conjunction with a reduced amount of sodium hypochlorite will improve the safety of the final product.

### **Effect of in vitro mechanical stress on the gene expressions of cyclooxygenases and prostaglandin E2 receptors in kidney podocytes**

Chronic kidney disease (CKD) is a burden to the human suffering community in terms of financial cost of care, lost of productivity, and human suffering. Approximately 16% of the US population suffers from CKD, and the number is expected to rise in the future. CKD is characterized by hyperfiltration leading to albuminuria and accumulation of toxic compounds in the body. Specialized cells called podocytes regulate kidney filtration. The first aim of this study is to investigate the mechanical stress on the expression of cytoplasmic processes and fibrous actin (F-actin), a protein in the cytoskeleton of the podocyte. This study also investigated if prostaglandin E2 (PGE2, a chemical in the kidney, is responsible for these effects. The podocytes were put under mechanical stress at 0.2 dynes for 2 hours. Mechanical stress resulted in the increased expression of cytoplasmic processes and F-actin. These results seem to be due to the increase in PGE2 levels. The studies showed that mechanical stress raises levels of PGE2, which changes the cytoskeleton of podocytes, resulting in changes in filtration. The second aim of this project was to investigate how PGE2 levels increase. This aim determined which enzyme, Cyclooxygenase (COX) 1 or 2 synthesizes PGE2. Also, this aim indicated which E-prostanoid (EP) receptors: EP1, EP2, EP3, and EP4 acts via PGE2. The results showed that the expressions of COX-1, EP1, EP3 and EP4 remained stagnant. The results of these studies may help in finding to drug to modulate the pathway to allow a safe way to delay the progression of CKD.

## **Novel treatment of hemoglobinopathies by modulating testis-specific protein, Y-encoded like 1 (TSPYL1) and fetal globin inducing factor (FGIF) gene expression: RNAi-mediated gene silencing affects $\gamma$ -globin gene transcription**

Hemoglobinopathies such as sickle cell disease (SCD) and  $\gamma$ -thalassemia are common genetic diseases that affect millions of people worldwide. Hemoglobinopathies affect hemoglobin, a protein in red blood cells that delivers oxygen to cells. People with SCD have abnormal hemoglobin molecules which distort red blood cells into sickle cells. SCD is related to vascular complications and is associated with a high morbidity rate. Symptoms can be treated by reactivating human fetal hemoglobin which contains  $\gamma$ -globin subunits. Regulation of human  $\gamma$ -like globin gene switching is controlled by several parameters and unraveling the mechanisms controlling  $\gamma$ -globin gene expression is important for discerning new targets for therapeutic intervention. The human proteins testis-specific protein, Y-encoded-like (TSPYL1) and fetal globin inducing factor (FGIF) represent potential targets for research. Using RNA interference (RNAi) to silence TSPYL1 and FGIF helps establish a correlation between target knockdown and  $\gamma$ -globin gene expression. Use of silencing RNA (siRNA) specific for TSPYL1 proves the hypothesized correlation. Research is currently being conducted with short hairpin RNA (shRNA) to further understand TSPYL1 and FGIF gene expression as it relates to  $\gamma$ -globin gene expression. Ultimately understanding the molecular mechanisms controlling globin gene switching may aid in the development of novel therapies to effectively treat hemoglobinopathies.

## **Detecting Mutations in the Gene Sequences of Hsp90 and Hsp90 isoforms in Prostate Cancer Cell Lines LnCap and PC-3**

In cancer drug discovery, it is common to screen chemical libraries for activity against a specific biological target in tumor cell lines to identify a chemical hit. The heat shock protein 90 (Hsp90) is an example of such a target wherein inhibitors have been designed to target both the N-terminal and C-terminal ends of the protein. The purpose of this study is to determine the mRNA coding sequence of Hsp90 homologs in cancer cell lines that are being used to screen for Hsp90 inhibitors. Understanding the mRNA and protein sequence of Hsp90 in the different cell lines will assist with our development of novel inhibitors for the treatment of cancer. The hypothesis is that DNA mutations in the Hsp90 coding sequence do exist in cancer cell lines. The procedure included collecting RNA from cell lines, preparing cDNA by RT PCR, setting up and running PCR, determining PCR products using gel electrophoresis, taking PCR products and inserting into a cloning vector, transforming the expression vector into bacteria for growth into larger quantities, mini-prepping DNA to purify plasmid containing the PCR product, purifying the sequence and comparing the wild type sequence with DNA sequence from cancer cell lines for mutations using the Mac Vector software. The results show mutations in the nucleotide sequences in all of the Hsp90 homologs, with amino acid mutations specifically in the Hsp90 $\beta$  and TRAP1 homologs. In the GRP94 homolog, there were no mutations seen in the amino acid sequence, after a mutation expressed in the nucleotide sequence. Hsp90 $\alpha$  was not considered in the results or conclusion due to its need for further optimization. The mutations found in this research revealed more about the Hsp90, its homologs and where mutations occur in the gene sequence. Given that HSP90 homologs are drug targets and that mutations in their DNA sequence have the potential to affect the way drugs bind to the protein, it is important to assess the mutational status of the target to fully understand the mechanism behind drugs that target HSP90.

## **The Effect of Hydrogen Peroxide, Anti-Bacterial Ointment, Sage and Rosemary on Bacteria Growth**

The uses of both synthetic and natural remedies to control bacteria growth have been used for years. This study investigated the effects of sage, rosemary, hydrogen peroxide remedies to see which one was able to control growing bacteria best over a span of three days. The remedies were applied to the growing bacteria and observed by tracing the bacteria growth twice a day. By counting all of squares that the bacteria covered for each one, it was found that the herb sage was the most effective for controlling bacteria.

## **Wild flower honey, clover honey, grapefruit seed extract, tea tree oil, and garlic as natural antibiotics on Staphylococci aureus, Escherichia coli, and Serratia marcescens.**

In the last couple of years the number of antibiotic resistant bacteria has been growing. So far there have been no reports of natural antibiotics becoming resistant. This study investigated the affects of wild flower honey, clover honey, grapefruit seed extract, and garlic on the bacteria Staphylococcus aureus, Escherichia coli, and Serratia marcescens. First a petri dish was smeared with bacteria, and then six wells were bored into the petri dish with a cork borer. Each well was filled with a different type of natural antibiotic except for the sixth well which was the negative control. The end results did not fully cover the hypothesis due to the fact that wild flower honey did not inhibit the bacteria at all. The best natural antibiotics appeared to be garlic and tea tree oil. In the future it would be interesting to try different types of natural antibiotics and bacteria. Also having a positive control instead of a negative control would be a good change because it would indicate whether the zone of inhibition was significant as compared to a known and calibrated antibiotic.

## **The Growth Effect of Cyanobacteria when Micronutrient Rich Malis pumila is Added**

Cyanobacteria can help the oil crisis. Biofuels from Cyanobacteria can help reduce world food costs, reduce the amount of carbon dioxide in the atmosphere, and create a reusable and sustainable form of fuel. Agricultural crops produce 100 gallons of biodiesel per acre per year, while an alga produces more than 10,000 gallons of biodiesel per acre per year. The United States could replace all of the diesel fuel it consumes by using only .5% of the current farm land. The United States' current goal is to bring down the cost of algae biodiesel to \$2 in a couple of years. In order to obtain results, the experimenter created plastic bags filled with algae, pond water, and half of them had apples. These bags were weighed and put into a temperate, controlled room for 3 weeks; afterwards, the bags were weighed. This data shows that each bag except for bags H and E lost weight. Every bag with apples lost weight. The observations did not support the hypothesis. In the future, the procedure would change by having a light instead of sunlight, have a better controlled containment area, and the container would be switched with one that sealed better.

## **The effect of bacteria, actinomycetes, and fungi in the soil on the growth of *Lolium multiflorum***

This experiment was designed to study the effect microorganisms have on plants. The use of microorganisms can significantly change the way plants grow. The knowledge of whether soil microorganisms help plants grow or stifle plants is an important finding for agriculture. The hypothesis proposed that if microorganisms are removed from one group of soil and grass, then the grass with microorganisms will grow taller. This project involved killing the microorganisms in half of the soil, and then growing the grass in two types of soil. To kill off all of the microorganisms for the experimental group, the soil was placed in an oven with and then tested in soy agar Petri dishes to insure that the experimental group's microorganisms had died. From testing the soil, the agar dishes showed no signs of growth for the experimental soil; on the other hand, the control soil was thriving. Both soils were then put to use with the grass seeds. In the end, it turned out that the control grass, which had a natural amount of microorganisms in the soil, grew over twice as tall as that of the experimental group. To conclude, the hypothesis was supported; microorganisms benefit the growth of grass. This study investigated the way microorganisms affect *Lolium multiflorum* grass growth. The average growth for the experimental group was 4.35 cm while the control group averaged a growth of 10.4 cm. The results show how important soil microorganisms are to plants. In the future, having three groups, one with added microorganisms, could show if adding microorganisms is beneficial.

## **Amount of *Escherichia coli* in common places where water is accessed in the Kansas City Area**

*Escherichia coli* 0157:H7 can cause serious health issues in humans like Hemolytic Anemia, Thrombocytopenia, and renal failure. These serious conditions are not to be taken lightly and neither is contaminated water. With regulated monitoring and testing of our drinking water we can prevent the contamination of our water. This study investigated three different sources of water; tap, bottled, and fountain, to see if any of the samples tested positive for fecal coliforms or *E. coli*. Ten samples of each source were tested to get an accurate conclusion. The hypothesis that the water from the fountain and tap would be at regulation standards was unsupported by the outcome of the experiment. Some of the tap water tested positive for *E. coli* and all three samples had some form of fecal coliform. This would imply that the tap water sample may have been contaminated with *E. coli* and that further studies need to be taken to prove or disprove this conclusion. In the future there should be stricter sanitization methods taken in the procedure of this experiment.

## **How Tadpole Growth is Affected by the Type of Water They are Grown In**

This project was chosen because many people enjoy keeping tadpoles as pets. If they want to increase the likelihood of tadpole survival, it would be necessary to know in what type of water tadpoles grow the best. From a scientific perspective, if the water in which tadpoles grow best is found, science classes that dissect frogs will be able to use bigger frogs, which makes it easier to see the organs and anatomy of the tadpoles. In order to get results, it was necessary to feed the tadpoles and change their water every week, make sure constant variables remained constant, observe the tadpoles, and wait for them to grow. The conclusions showed that Group A (the tadpoles in distilled water) increased by 126 percent of its original average length over the course of the experiment. Group B (the tadpoles in tap water) increased by 186 percent of its original average length. Group C (the tadpoles in the lake water) increased by 152 percent of its original average length. The results showed that the tadpoles in the tap water grew better than the tadpoles in the distilled water and the lake water. Therefore, if tadpoles are being grown for scientific purposes or kept as pets, it is best to keep them in dechlorinated tap water. This study investigated the effects of different water on tadpole growth. The results show that different types of water do have an affect of the growth of tadpoles. Further study would include longer study time for the tadpoles reach adulthood for more accurate results.

## **The Effects of Cyclical or Non-Cyclical Lighting on the Growth and Development of *Vanessa cardui* (Painted Lady butterfly)**

The effect of light on the development of caterpillars is important because it could help in quicker breeding of the butterflies. It could also lead to new technologies that allow for sexing in a younger caterpillar. This study investigated the cyclical and non-cyclical effects lighting and gender on the growth and pupation of *Vanessa cardui* caterpillars, commonly referred to as the painted lady. The caterpillars were separated into three groups and placed in separate locations with the desired lighting. The length of the caterpillars was measured twice a day until they had pupated. Upon emergence, they were sexed and released. Future studies might be changed so that each group has an equal amount of males and females. In addition the effect of infrared and ultraviolet lighting upon development could be investigated.

## **ENGINEERING AND PHYSICAL SCIENCES**

### **The Optimization of an Automobile's Child Safety Seat**

Nearly fifty percent of children who have been involved in severe accidents have received serious spinal injuries because they were not seated in a proper child safety seat. Child safety seats compromise the safety of children in automobiles. Children are severely injured in car accidents simply because the seat belt isn't designed accurately for youngsters. Due to the inconvenience and hassle of moving booster seats most parents neglect the safety of their children by not equipping vehicles. A booster seat that doesn't require installation and is convenient will be used frequently by adults and raise the rate of safety among children. A prototype of a convertible booster seat was developed and the force and time required to convert the car seat into a booster seat were successfully tested. The testing of the average force required unlatching the booster seat along with the time required to unlatch it both passed, while the consumer survey and the test for the average torso length failed to satisfy. A comfortable and convenient prototype was developed to encourage the use of child safety seats within vehicles.

### **Optimizing The Modern Wheelchair**

Wheelchairs are used to propel humans in order to assist with lower body disabilities. Some patients cannot use their upper body fully therefore making hand motion discomforting. A prototype was developed using handles and gears to accommodate this discomfort. The prototype was constructed out wooden gears and PVC pipes so that it could be propelled with hands. The prototype was successful in distance tests while failed in timed tests.

### **An Interior Lighting System to Reduce Dependence on the Electric Grid**

The purpose of this project is to assess the effects of multiple alternative lighting techniques in order to relieve individuals from relying on the municipal electric grid to light their various structures. The various alternative lighting set-ups were tested under controlled conditions: light source kept constant, light source distance from test object kept constant, light meter used kept constant. An old tanning lamp was used as the controlled light source. The methods tested included: deck prisms, blinds made of fluorescent plastic, as well as combinations of the two, with the blinds both opened and closed. For each set of tests, the light source was placed at a measured, specific angle with relation to the top of the test box. Based on the measurements of the angles from the first set of tests, the same angles were applied to the other test sets. It was found that the prisms had a specific angle with relation to the light source ( $55^\circ$ ) that allowed the most amount of light into the test box (which was sealed to prevent light from entering when where not wanted). When closed, the blinds were found to be most effective in sunset/sunrise scenarios where the light was placed at the horizon point or about  $0^\circ$ . In addition, data indicates that LEDs powered by solar, photovoltaic panels have great potential to further reduce the need for electric-grid-supplied power.

## **Horizontal Angle Efficiency of Wind Turbines**

Wind power could be a very productive and environmentally clean energy source, but currently it is not as efficient as some people may want it to be. This study investigated how different angles of the horizontal axis affected the efficiency of the wind turbine. To test this one wind turbine was created and then 5 tests were done at each angle. The angles include 80, 90 (the constant), 100, and 110. The results of this experiment show us that the current use of a 90 degree angle of the horizontal axis in a wind turbine is the most efficient. However, these results show the efficiency of a very small wind turbine. If someone were to conduct the experiment in the future then one would definitely want to construct a larger in scale wind turbine.

## **Types of Soil Determine Absorbency Rate**

Not all plants and/or crops grow to be as healthy as they are actually able to. This is why soil absorbency is so critical. If someone wants the best crops or plants in their garden, they would need a soil that is absorbent so that the soil can hold water for the plants to use if there is a drought or the plant don't get watered as often as they should. To do this experiment, you need four different types of dry soil and you need to be patient. All the materials are mostly household items, so no trouble there. The experimenter is testing to see which soil has the most potential to hold the most water. Do at least ten trials for each type of soil. As a result from the experiment, the experimenter should discover that the plain backyard soil absorbs the most water.

## **Designing a Strong, Light-Weight Building Material Based on the Internal Structure of Bamboo**

The purpose of this project is to design and create a synthetic shaft utilizing the general shape and internal design found in natural bamboo. Essentially this product will be a thin, hollow, circular tube comprised of individual, long fibrous structures bunched together around another, smaller, central tube. The synthetic fibers utilized will be

## **Utilizing Potato Waste for the Synthesis of a Biodegradable Computer Casing**

One of the growing concerns of the world is the inability of our massive quantities of plastic to degrade. These plastics stay in landfills for hundreds of years, poisoning the environment. It is expected that combining starch derived from potato waste and glycerin will result in an alternative, degradable plastic suitable for computer casing. It is also predicted that adding the fibers left over from the potato waste and micro particulate glass spheres will further strengthen the plastic. The base plastic compound began with starch, glycerin, and water. This was stirred and heat treated until gelling occurred. Further batches of plastic were made, incorporating the aforementioned additives before the heat treatment began. The potato waste fibers significantly increased the strength of the plastic. The glass spheres increased the strength somewhat, but it is expected that they will also increase the heat resistance of the plastic. Thus, a plastic derived of potato waste starch, potato waste fiber, glycerin, and glass spheres demonstrates the potential to replace standard computer casing as a biodegradable alternative.

## **The Effect of Time and Temperature on Distilled Petroleum**

My project was proving if there is a specific time of the day or week that you should buy gasoline for you car. Checking the temperature inside, outside, and in the ground then comparing it to a graduated cylinder that was filled with 47ml of unleaded gasoline. I collected data for 18 days, and throughout those days luckily the weather fluctuated greatly.

## **The Effects of Cryogenic Temperatures on the Efficiency of a Rotary-Electro Mechanical Device**

For those of you who have been living in caves for the past several years, let it be known that our precious earth is troubled by mankind. We have become a parasitic cancer to this planet, using its resources to feed our ravenous population, increasing exponentially by the year. Yet we've come to a crossroads. All parasites rely on the life of their host, and our earth is dying. Either we begin to care, or this beautiful, unique gift of a planet, and possibly the most intelligent species in the universe will be lost forever. So far, many "green" leaps have been made, and the pressure to use electricity to power our future is growing. Technology today has reached incredible new heights, yet is far from perfect. The motors and generators employed to turn electrical energy into shaft torque and vice versa are all inhibited by the baseline resistance of the copper windings, the electrical raceways that give the devices their unique ability to create and use this source of energy. Copper is not a superconductor, but is more abundant and far less complex than true superconductors (such as a promising transition metal compound only known as, for obvious reasons, its abbreviated form:  $(T_{10.5}Sn_{0.5})Ba_2(Ca_{0.5}Tm_{0.5})Cu_{20x}$ ) which require incredibly complex processes to produce even a small amount. Copper happens not to be a true superconductor, but loses a substantial amount of resistance nearly parallel in correspondence to a decrease in temperature. Effectively, cooling a motor or generator could result in a substantial increase in operating efficiency. I used a simple alternating current electric motor, set up with an aluminum flywheel to create the desired amount of physical load, using inductive friction produced by neobodium magnets. The copper coil of the motor was wrapped in aluminum tubing employed to channel liquid nitrogen about the device and cool it substantially. A laser tachometer was used to collect rpm readings in correspondence with a Lab Pro temperature probe and processing unit. The results appeared to support the hypothesis. They were not as outstanding as was hoped, but prove the principle with a simple device. Several problems were addressed as far as the nitrogen feed system, but overall the procedure was uneventful. A second experiment was done to examine the effect cooling had on the resistance of a copper coil, and the results were fairly conclusive as well. The experimentation seemed to produce viable and useful results for further testing.

## **Improving the Gel Point of Waste Oil Biodiesel Using Butanol**

Biodiesel is an alternative fuel derived from vegetable oil. Over recent years production has improved significantly, but the temperature at which it freezes, or the gel point is still an issue plaguing progress. This project resolved to decrease the gel point of biodiesel with butanol, an alcohol that may be easily producible from algae. Butanol was added at different points in the production of biodiesel, once as a replacement for methanol during the transesterification process, and again as an additive in the produced biodiesel. It was found that the addition of butanol in either phase did in fact lower the temperature of the gel point, but the replacement of methanol with butanol was found to have the most significant impact on this temperature. This decrease was fairly substantial, over 14 degrees Celsius lower than that exhibited by standard biodiesel.

## **Measurements of Phosphate and Its Effect on Oxygen**

Individuals from around the country live in a world full of chemicals, toxins, and numerous elements. One such element is phosphate, which can pose a negative impact to its surrounding environment. The researcher was able to see how different measurements of phosphate affect oxygen by filling forty-four bowls with five hundred milliliters of water and putting four different amounts of phosphate into four bowls. The science investigator used eleven bowls for each of the four measurements, and after waiting two weeks, she tested each one using the dissolved oxygen testing process. As a result of completing the dissolved oxygen tests, the researcher learned that having an excess amount of phosphate in lakes and ponds causes an extreme growth of algae, reducing oxygen levels. Eventually, both plant and animal species die due to the lack of oxygen available. The researcher can conclude that having an overload of phosphate in a pond can cause contamination, which disrupts the surrounding wildlife. In the future, she might change her project by keeping the bowls indoors under grow lamps, and using clear containers instead of colored. The researcher gained a great deal of knowledge that she can use in future studies and experiments.

## **The Quantity of Atmospheric Particulate Matter**

Dust Particles and Pollen in the air accumulate in different amounts, in different areas due to the environment. Dust Particles and Pollen can cause serious human health problems. This study investigated in which area, more dust and pollen accumulates. This was accomplished by placing dust collectors in 3 different locations (a closet, dining room, and basement). Each collector was left in its location for approximately 2 weeks. Once the 2 weeks were over the collectors were taken and examined under a microscope. The results were that the most dust and pollen accumulated in the basement. These findings supported my hypothesis. In the future I will compare more variables, but will only test in the basement testing location.

## **Efficiency of Wind Generators**

The goal for this project was to find out what type of blade design and what angle worked the best on a wind turbine. I tried to make a wind turbine that you could attach different blades and set them at different angles to isolate that one variable. If you are going out to purchase a wind turbine you want a turbine that produces enough power and is cheap, to do that you need an efficient design starting with the blades. I cut out 3 blades for 3 different designs out of balsa wood and attached them to a hub. I attached an electric motor to a pole and attached the hub directly to the motor. I hooked it up to a volt meter and put on the different designs and ran it with a desk fan. It produced around .007V which told me I need a gear box to make it run faster. I found out that the bigger blade is not the most efficient; the blade with less surface area actually worked the best.

## **Efficiency of Micro-Turbines**

Four factors (speed of wind, resistance of the load, the number of turbine blades, and orientation of turbine blades), which are related to the overall efficiency of a wind turbine generator system, were studied. After each experiment the power contained by the wind due to its kinetic energy and the electrical power output of the generator were calculated. Overall efficiency was calculated as the ratio of the wind power to the electrical power generated. I conducted ten trials and calculated the standard deviation to check if there was an overlap among data. For the graphs the average numbers from ten trials were plotted; since the standard deviation was so small, I could accurately represent the data with the average values of ten trials. My dependent variable for all four experiments was the overall efficiency of the system. In experiment 1, my dependent variable was the speed of the wind blowing from a fan; for experiment 2, it was the resistance of the load; for experiment 3, it was the number of the turbine blades; for experiment 4, it was the orientation of the turbine blades. The graph of the experiment 1 indicates that the overall efficiency decreased as the speed of wind increased; as the speed of the wind decreased, the overall efficiency of the system also decreased. There is a mid-point that produced the maximum overall efficiency, which was 9.7%. For experiment 2, the 40 ohm resistor produced the maximum efficiency of 4.70%. For experiment 3, the six turbine blades produced a maximum efficiency of 4.12%. Due to an asymmetry that caused a balance problem of the turbine, the graph had two maxima when there were 3 or 6 turbine blades. For experiment 4, the maximum overall efficiency was 5.71% when the angle of the turbine blades was the 70° relative to the direction of the wind. Aside from experiment 3, which had an asymmetry that produced a balance problem of the turbine blades, the other experiments indicated that there were maximum values for the overall efficiencies. As the independent variable increased or decreased from the maximum value, the overall efficiency decreased.

## **Safe and Efficient Storage of Oxygen Tubing**

The use of fixed-location oxygen therapy is regularly prescribed for a variety of different respiratory and cardiovascular diseases, however current methods of storing the tubing through which the oxygen is delivered leave the tubing vulnerable to kinking and tangling, and often create falling hazards. The researchers sought to develop a lightweight, portable device to safely organize and store oxygen tubing in a way that maintains consistency of flow. The investigation began with research of existing solutions, followed by an original design. The researchers' design was compared based on the problem objectives to the existing solutions in a design matrix to optimize the design before construction. The device was then constructed. A survey was taken to measure the perceived effectiveness and usefulness of the prototype in the application described. The prototype was successful in the test by exceeding the benchmark set for satisfaction in the majority of the public.