



Frontenac, Lennox & Addington Science Fair

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Prefair Report

4101 Lily Collard, Ally Hall

Div/Cat Life and Earth / Senior

Title: Will nanoplatelets extracted from genus species prove beneficial to concrete function as well as the

Summary: Ordinary concrete is made of water, aggregate (such as gravel and sand) and Portland cement (cement that is manufactured from limestone and clay and that hardens under water). The latter ingredient is responsible for most of the carbon emissions from concrete production. Within concrete, calcium silicate hydrate is the primary strengthening component in its mixture, however, manufacturing concrete is not a very environmentally friendly process. Carrots could be the solution to this issue.

The nanoplatelets from root vegetables, such as carrots, naturally contain a high amount of calcium silicate hydrate. Adding these vegetable particles to Portland cement (basic manufactured concrete) will immensely increase the amount of calcium silicate hydrate in the substance, making the concrete stronger altogether. The addition is greatly beneficial to the material, and as a result, once the platelets are added, 40 kg less of Portland cement is needed per cubic metre. This helps to lower the carbon emissions the construction industry produces while manufacturing concrete by reducing the amount of regular concrete needed.

On average, each year, 3 tons of cement are used by every person on the planet. With the production of concrete being a large contributor to the emissions of CO₂ into our atmosphere and with CO₂ being a harmful greenhouse gas, this process is poisonous to our planet. If the amount of concrete manufactured can be reduced, less CO₂ will be released into our atmosphere. This project will aim to demonstrate said impact, and how it can be incorporated into the present manufacturing process.



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Prefair Report

4102 **Abdelrahman Nouredin**

Div/Cat **Life and Earth / Senior**

Title: **The Effect of Polymyxin B Concentrations on Bacterial Growth**

Summary: Bacteria is a prokaryote that divides through binary fission and can be both beneficial and detrimental to our health. Our body can distinguish if a cell is foreign because of antigens on the bacteria itself and use antibodies to destroy the cell using various methods. Polymyxin B or Gramicidin are active ingredients found in Polysporin eye drops that kill bacteria by altering its membrane and causing the bacteria to lyse (cannot control osmolarity). By growing bacteria in agar Petri dishes, chads dipped with various concentrations of the Polysporin eye drops will form zones of inhibition. The area and perimeter of these zones can then be calculated using the app SketchAndCalc. It was hypothesized that as the antibacterial concentrations increased, the area and perimeter of zone of inhibition would also increase. The independent variable chosen was the concentration of antibacterial the chads were dipped in while the dependant variable was the area/perimeter of the zones of inhibition. Control variables included the temperature the bacteria were exposed to, the length of time the bacteria were given to grow, the type and mixture of agar available to the bacteria and the type of antibacterial (Polymyxin B) amongst others. After the tests were conducted at 0%, 20%, 40%, 60%, 80% and 100% concentrations of antibacterial (where 100% is the normal store-bought concentration), the zones of inhibition were found to largest for the 100% concentration and smallest for the 0% concentration (distilled water). There was a clear increasing trend between the averages for all five trials at each interval as the concentrations increased. To prove the data was significant, various statistical tests such as R² values, 95% confidence intervals, and an ANOVA were conducted. The alternate hypothesis was confirmed based on the statistical analysis conducted. It was concluded that as the concentration of the antibacterial increases, the area and perimeter of zone of inhibition also increases.



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Prefair Report

4103 **Eva-Marie Daines, Reagan Stalkie**

Div/Cat **Life and Earth / Senior**

Title: **Genetically Modified - With Some Modification**

Summary: This project will monitor the effects of wind on genetically modified seeds to represent how the seeds move in the wind and can cross contaminate with Organic fields. The purpose of this project will be to consider the benefits and possibilities of creating a genetically modified seed exterior to prevent the movement of genetically modified seeds into Organic crop fields. The movement of GMO seeds into Organic crop fields often cause farmers a large amount of money loss every year because their organic fields are contaminated and can not be advertised as organic crops. The project will examine the way that a simple gene modification could allow the shell/exterior of crop seeds to be more resistant to elements of nature such as wind. With a heavier and/or more durable seed shell, less seeds could be cross contaminated which would result in much less money loss for farmers per year when harvesting unintentionally contaminated fields. The modified seed shell would be required on seeds which are already Genetically Modified. This project will also study the evolution of seed shells and for what reasons the shells have evolved in the ways that are being presented in crops today, possibly a new modification would evolve into the future of seeds and crops which are useful to humans every day.



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Prefair Report

4104 **Elizabeth Reid, Hunter Bannon**

Div/Cat **Life and Earth / Senior**

Title: **Effects of Colour Light on Small-Seed Germination**

Summary: In this experiment, small-seeded Grand Rapids lettuce seeds will be germinated under the conditions of differing colours, and sources of light. Red, Blue, and White LED lights are to be tested against natural light control samples as well as no light control samples. Specialized boxes are being built to house the seeds so that they are protected from the effects of external light sources. Each of the boxes will contain six seeds each, that are planted in identical Peat Pellets that have the same soil contents to maintain soil nutrient consistency. These boxes will be kept in a regulated greenhouse with the temperature of the environment being measured throughout the duration of the experiment. The lamps for the LED bulbs are kept on constantly, approximately 4.5 inches over the soil, in hopes of maximizing their effects on the seeds for more evident results. Maturation of the Grand Rapids lettuce plants should occur at around 45 days, however the critical growth period for the purpose of this experiment is the germination period which naturally occurs within the first two weeks. Once the seeds have gone through their germination period, their growth will be measured compared to the growth of the seeds of their environment as well as average growth compared to the average growth of the seeds from other light sources. In addition to stem growth, the root growth patterns will be analyzed with consideration to soil moisture as well as areas of nutrient-rich soil to determine the consistency of the soil or how the light environments effect moisture content.



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Prefair Report

4105 **Kate Brown, Maddy Fretts**

Div/Cat **Life and Earth / Senior**

Title: **Climate vs Cows**

Summary: Our project compares and contrasts local dairy cows' milk production and quality data against local weather data. We will compare the milk production, butterfat, and somatic cell count in our animal sample as a general indicator of milk quality. This data will be collected using an online database that stores information about shipments of milk sent in from dairy farm operations. Weather patterns and climate will be sourced from local weather resources. We would like to display the data in graphs that look at short term and long term weather patterns/ climate and contrast them against the elements of the milk quality and quantity produced. Based on this data, it is our goal to be able to draw conclusions on the effect world climate change is having and will continue to have in the future, on the milk production and quality of milk produced by dairy cows. This information could provide an idea of what farmers should expect in the near future in terms of climate change and the dairy production of their livestock. As well, the conclusions drawn from this data could predict future trends in dairy product pricing and availability. As the global climate continues to rise and create inconsistent high and low-temperature extremes within weekly temperature recordings, it is important to examine all of the impacts it may have on our agricultural industry. Our project aims to examine this relationship on a small scale between local dairy cows and local weather data.



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Prefair Report

4106 **Esther Kim**

Div/Cat **Life and Earth / Senior**

Title: **Radish Seed Germination in Saline Solutions**

Summary: This experimental study was conducted to explore the effect of salinity on the germination and growth of radish seeds (*Raphanus raphanistrum*), in an effort to model the impact of saline soils on monocrops.

Particularly in arid areas, irrigation is a common method used to distribute groundwater to crops. This groundwater eventually evaporates, leaving behind a concentration of salt in the soil that continuously builds up. Since imbibition in seeds are reliant on a solute concentration gradient, this may induce detrimental effects on future crops as the gradient between the seed and soil medium become less differentiated. These effects can include a decreased yield, which is an issue that must be addressed as the world population, and consequently, the need for food, continues to rise.

Given this, a greater concentration of sodium chloride ($\text{mol}\times\text{dm}^{-3}$) would result in a significantly decreased average difference in mass (g) of the radish seeds after germination (alternate hypothesis).

The salt concentrations were chosen based on a similar study done in the past. For each concentration of salt, five seeds were placed in an enclosed petri dish, which included a piece of paper towel soaked in the appropriate saline solution. The seeds were left to germinate for seven days, in which they were carefully observed.

From the qualitative and quantitative observations, as well as the statistical tests, it was concluded that as the molarity of sodium chloride ($\text{mol}\times\text{dm}^{-3}$) increases, the average difference in mass of the radish seeds after germination significantly decreases. This subsequently rejected the null hypothesis (of no correlation) and accepted the alternate hypothesis.



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Prefair Report

4107 **Sophia Elena Bakyta**

Div/Cat **Life and Earth / Senior**

Title: **How much ascorbic acid can we C in kale?**

Summary: With more general awareness and knowledge around maintaining a balanced diet, Brassica oleracea var. Sabellian (commonly known as kale) is often regarded as a "superfood" due to its high vitamin content, including ascorbic acid, or vitamin C. Vitamin C is an essential component in our diets as it is not produced endogenously and has significant roles in proper immune system function, as well as in collagen synthesis. Vitamin C also acts as an important antioxidant, meaning it can be oxidized to form dehydroascorbic acid. This reduction-oxidation reaction can occur in our food and is what causes a depletion of vitamin C content before consumption, suggesting our use and cooking of food can impact overall vitamin acquisition.

The purpose of this experiment was to explore the depletion of vitamin C in kale under regulated conditions. It was hypothesized that over time and with exposure to oxygen, light, and heat (as kale was not left in a favorable, colder environment), vitamin C content would decrease as more dehydroascorbic acid formed.

A preliminary experiment was carried out to determine a standard curve from which vitamin C content could be determined. This was done using known masses from standard 500 mg vitamin C tablets. Prepared solutions of varying concentrations were used in an iodometric titration, a starch-iodine complex formed regarded as an indicator of the endpoints. A linear trendline was found to represent the collected data points very accurately.

The kale used was purchased on the first day of experimentation. Three titration trials were carried out per day over the course of five days. The averages were calculated for each day, from which the respective vitamin C contents were determined. Results showed a rapid decrease of titrant needed to reach the endpoint each day, suggesting that over time there was less vitamin C available to prevent a color change in the solution. This allowed more molecular iodine to successfully react with starch.

The results obtained supported the initial hypothesis, though uncertainties were recognized and further experimentation using more trials and with different conditions is encouraged. More research into the effects of cooking and storage methods of other major sources of vitamin C, or of vitamins such as K, A, and B, would be helpful in understanding the important role chemistry plays in our lives and overall health.



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Prefair Report

4108 **Nathan Pilkey**

Div/Cat **Life and Earth / Senior**

Title: **aSALTING our Ecosystems: Examining the effect of road salt on the environment**

Summary: This project investigated how salt used to deice roads affects ecosystems. Specifically, it examined how increasing concentrations of salt affect plant growth and how salinity affects dissolved oxygen content in water.

In order to examine the effect of salinity and plant growth, beans were grown in increasing salinity. Before growth, each bean was massed. After three days, three beans from each concentration were massed. This was repeated after six, nine, and twelve days. Bean growth was evaluated through the percentage change in mass. The results found that as the concentration of salt increased, plant growth decreased.

The second aspect of the investigation examined how the salt concentration in water affected concentration of dissolved oxygen. The use of road salt in North America has been documented as contributing to increase salinity of lakes. Oxygen content is used as an indicator of lake health, and is a vital component of the survival of aquatic life.

This investigation measured how increasing salt salinity affected dissolved oxygen content. Oxygen content was measured through the Winkler Method. The Winkler method is a reduction-oxidation titration that measures the dissolved oxygen content in a given sample. The experiment found that as salinity increased the dissolved oxygen content of the sample decreased.

These results have widespread applications in ecosystems and agriculture across North America. The amount of road salt being used on roads continues to increase, which directly increases the amount of runoff. This salt runoff contaminates and pollutes the ground and lakes in the area, having detrimental effects, as documented in this investigation.



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Prefair Report

4109 **Daniel Levin**

Div/Cat **Life and Earth / Senior**

Title: **Effect of pH on Radish Seed Germination**

Summary: The experimental study explored whether an increase or decrease in the pH of the environment in the Petri dish would affect the germination rate of *Raphanus raphanistrum* subsp. *sativus* (radish seed) measured by the number of seeds germinated at the end of five days. With changing patterns of soil alkalinity and acidity around the world as a result of evolving weather patterns, understanding the effects of pH variance in soil is crucial to sustaining crop growth and yield, ensuring a strengthened industry and that global agricultural needs are met. Germination and plant growth will occur when the conditions of light, oxygen, temperature, water and nutrients are satisfied. The condition of the soil in which the seed is placed is critical to the survival and growth of the seed. A greater amount of H⁺ in the soil causes an acidic pH level below 7, resulting in acidic water uptake. As pH affects the osmotic pressure, a lower pH can increase osmotic pressure and as such water uptake of the seed increases. This can cause an increase in the germination rate; however, water uptake will eventually inhibit to prevent seed damage at a certain osmotic pressure. Oppositely, an increase in OH⁻ or alkalinity of the water in the soil can decrease osmotic pressure and reduce imbibition, ultimately slowing down the rate of germination. It was hypothesized that there would be a significant difference in the rate of seed germination of the radish seeds at the end of five days as the pH increases from pH 1 to 11. There will be an optimal rate of seed germination at a slightly acidic pH level. It is predicted that there will be a non-linear increase in germination rate from pH 1 and a decrease in germination rate from pH 11 until an optimal pH is reached. Throughout five days, five trials for pH 1, 3, 5, 7, 9, 11 were conducted with ten seeds placed in each Petri dish. In order to better interpret the data seen as well as provide further insight into the germination rate, the germination process was divided into three stages. Stage one accounted for seeds imbibition, stage 2 occurred when the cotyledons and radicle were visible, and stage 3 was once the leaves appeared. Data was collected on the number of seeds in each germination stage each day, as well as the total number germinated at the end of the trial. Graphical and statistical analysis were used to analyze the results of the data. In conclusion, there was a significant correlation between the pH of the solution in which the seed was placed and the rate of germination. Through an ANOVA test resulting in a p-value of 0.03, the alternative hypothesis was proven correct. Overall, acidic pH levels had a higher germination rate than the basic solutions. pH 5 was determined to be the optimal pH at which germination occurred, followed by pH 7, 3 and finally 9 with pH 1 and 11 not undergoing germination.



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Prefair Report

4110 **Sophia Van**

Div/Cat **Life and Earth / Senior**

Title: **Effect of Temperature on Sugar Concentration of Bananas**

Summary: This experimental investigation was conducted to analyze the effect of temperature on the sugar concentration of bananas (*Musa Acuminata*) over a period of time, in which the data collected can be utilized to aid in fruit transportation and storage options for businesses and households. It is hypothesized that the bananas stored on the counter in room temperature would ripen more quickly than the bananas stored in the fridge, as the cooler temperatures within the fridge would result in a decrease in ethylene binding and lower the enzyme activity (converting starch, amylose and amylopectin, to sugars through enzyme breakdown). In order to test this hypothesis, a refractometer was used to measure the sugar concentration (Brix %) of banana samples over the span of eight days, with 2 trials tested each day from the two storage locations, the fridge and the countertop. Alongside the sugar concentration measurements, qualitative observations were obtained through side-by-side comparisons of the bananas from both locations, in which pictures were taken of the peel and a cross-cut of the bananas. At the end of the experiment, the raw data was analyzed through a graph, in which the slope and trend line of the averaged trials were observed. Overall, the experiment disproved the null hypothesis, and supported the alternate hypothesis.



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Prefair Report

4111 Shivani Patel, Mansi Patel

Div/Cat Life and Earth / Senior

Title: Extracting MAA's (mycosporine-like amino acids) from macroalgae and coral

Summary: The primary source of the Earth's energy is sunlight, which is harnessed by organisms and man-made technology in order to be converted to usable energy. For humans, ultraviolet (UV) radiation is important to interact with naturally-present steroid acid to produce vitamin D. Sunlight is also essential for all life on Earth, as it is the primary variable for photosynthesis in all plant life. However, excessive sunlight exposure can damage the DNA of cells due to the harmful UV radiation.

In order to prevent damage from UV radiation, some bacteria, fungi, algae and marine invertebrates, produce mycosporine-like amino acids (MAAs) as a natural UV protective compound. MAAs are small (<400 Da), water-soluble, secondary metabolites, that have natural sunscreen-like characteristics. MAAs can absorb UVA and UVB ranges of 310 to 365nm.

These properties found in marine organisms and animals may be modified in order to be applied to humans. Scientists are testing the effectiveness and ability to use MAAs as a natural sunscreen for humans and it is predicted that the extraction of MAA's may be formed into pills of natural sunscreen. This is important because if this becomes a reliable source of UV protectant, it would become an eco-friendly alternative to generic sunscreen, which often includes toxic chemicals. Sunscreen's toxicity emerges from its main active ingredient, called oxybenzone. Whether sunscreen is being used at beaches, waterparks, or pools, chemicals from it end up polluting our oceans. In the oceans, coral reefs are the main target for oxybenzone and they are being increasingly damaged, bleached and deformed. Oxybenzone has shown to disrupt coral's reproduction and growth, due to negative influences on the DNA. Alongside coral reefs, other marine life such as algae, sea urchins and fish are affected by oxybenzone as well.

As well as the harmful effects on marine life, oxybenzone was named "Allergen of the Year" by the American Contact Dermatitis Society in 2014 (Brunk, 2014). Oxybenzone has also been linked to low sperm count and male infertility, early puberty in girls, and an increase in hormone-related cancers in both males and females. The harmful effects of the extremely common chemical in sunscreen help fuel the need to produce a safer sunscreen, for both humans and marine organisms.

In order to further study the potential of using MAA as an ingestible sunscreen for humans, we have developed a procedure where homogenized samples of coral and algae will be subject to spectroscopic analysis. Then, the resulting wavelengths will be compared to try to determine patterns among the ability of each sample to absorb UV light. After this, the samples will be evaporated to extract MAAs and then will be further subject to gel electrophoresis. By doing this, we wish to compare the separate molecules to determine if there are any patterns among the molecular size of macromolecules present in both samples. The purpose of this procedure is to extract MAAs and prove that MAAs were extracted through this process.



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Prefair Report

4112 **Cameron Smith**

Div/Cat **Life and Earth / Senior**

Title: **Fruit for Fruit: Combating Droughts With Orange Peels**

Summary: Question: Can a biodegradable, inexpensive super absorbent polymer be made from household materials for agricultural purposes?

Purpose: Developing countries are highly susceptible to drought. The subsequent famine due to a lack in agriculture can lead to millions of deaths annually. One of the most effective methods of combating droughts is through the use of super absorbent polymers (SAP). SAPs absorb high quantities of water relative to their own weight. The water is absorbed around the roots, preventing drainage and reducing the need to regularly water plants. However, these are neither biodegradable, nor cheap. Being highly inaccessible to developing countries, they are in desperate need of a useful, cost-effective solution. Polysaccharides have been found to be extremely absorbent. However, they are only absorbent when cross-linked to create a hydrogel. Orange peels, containing very high quantities of pectin, can be cross linked with avocado skins - which are capable of emulsion polymerization - to create a biodegradable, cheap super absorbent polymer.

Methods:

Preparation of SAPs:

1. The peels from four oranges were placed in a large pot
2. 20mL of lemon juice and 500mL of water were added to the peels
3. The peels were brought to a boil over high heat
4. The peels were left to simmer for an additional hour, to reduce the water
5. The peels were placed over a strainer and left for 24 hours
6. The collected juice was used as the Orange Peel Solution

1. Two avocados were then peeled and added to the orange peels
2. The peels were cut into extremely fine pieces and placed on a baking sheet and left in the sun for 10 days
3. 60ml of the orange peel solution was added to the sun-dried peels
4. The peels were baked in the oven at 350°F for an hour
5. The peels were crushed into a coarse powder with a mortar and pestle
6. The powder was used as the Cross-Linked Powder

1. Four diapers were cut open
2. The cotton-like material inside was placed into a plastic bag
3. The bag was shaken until all the SAPs had collected into the bottom of the bag
4. This powder was used as the Super Absorbent Polymer (SAP)

Conducting of the Experiment:

1. 1.5kg of soil was placed into a tray
2. 10g of the SAP was scattered evenly across the soil
3. 1.5kg of soil was added on top
4. The soil was mixed around by hand
5. Steps 1-4 were repeated with the Orange Peel Solution and the Cross-Linked Powder



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6. One control group with only soil was used for comparison
7. 20 pre-grown bean plants were placed in each soil sample
8. Each soil was watered with 1.0L of water
9. The soil moisture and number of dead plants were measured every day

THE RESULTS OF THE EXPERIMENT WILL BE PRESENTED AT THE FAIR



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Prefair Report

4113 **Naomi Loughlin**

Div/Cat **Life and Earth / Senior**

Title: **Water Agitation and Dissolved Oxygen Concentrations**

Summary: Over the past year I've worked as a lifeguard at an indoor pool which had two pools: one for the water slide and a second larger pool for swimming. Having done pool tests frequently for both pools, I noticed that the pH of the water slide pool changed more drastically than the main pool and that the alkalinity of the water slide pool was consistently higher than that of the main pool. The only difference between the two pools physically was the water slide, thus I wondered how the slide influences the chemicals. The slide exposed the water to more contact with the air as it runs down the slide, thus the water is more agitated and mixes with the air around it, allowing oxygen to dissolve into the water.

To test the dissolved oxygen concentrations in the water samples I will use the Winkler Method. I will also be altering some of the chemicals used and the concentrations used for safety purposes. Each water sample will be agitated by a magnetic stirrer. Trials of water will be carried out with agitation times of 0, 1, 2, 3, 4, and 5 minutes. These will all be repeated 3 times.

I predict that with increased agitation, dissolved oxygen concentration will also increase (positive correlation).



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Prefair Report

4114 **Criswyn Paul**

Div/Cat **Life and Earth / Senior**

Title: **Are Plants Nuts for Coconuts??**

Summary: Will the concentration of coconut water (ml of coconut water/100ml of coconut water-water solution) affect the root growth, as measured by root length (mm), of white clover seeds?

Coconut water has been used in many countries like India for centuries thanks to its abundance of nutrients, vitamins, minerals, antioxidants, amino acids, enzymes, growth factors and phytohormones. Cytokinin is the growth hormone that facilitates growth, development and aging of the human tissue. In the case of plants, farmers apply cytokinin to seeds in drought seasons resulting in a 5-10% increase in crops. The higher levels of cytokinin will induce meiosis and cause cells to degenerate at a slower rate while the higher levels of auxin in the root primordia will cause differentiation and growth.

In this investigation, white clover (*Trifolium repens*) was used as they are very suitable for the apparatus utilized and should provide results within the seven-day experimentation period. White clover germinates and sprouts in two to three days in ideal temperature conditions of 18°C to 30°C. It requires good levels of nitrogen, sulphur, potassium, and in growth with grasses molybdenum is required. High nitrogen levels can inhibit the growth as they can increase salt contents in the soil causing dehydration

If the concentration of coconut water (ml/100ml) is greater, the average root length of the white clover seeds after germination will increase. This is because the increase in concentration of nutrients and phytohormones will hypothetically promote root growth and cause the seed to sprout faster.

I had 5 concentrations of coconut water (10%, 20%, 30%, 40%, 50% coconut water to water) and a control (0%) solutions to treat the seeds. The root growth was measured every day at 6pm. The lighting and heat conditions were maintained for all trials through the experimentation period.

In conclusion, the alternate hypothesis was rejected as there was insignificant change within the root growth in the various coconut concentrations to support it. The control in the end had the most successful growth meaning that the addition of coconut water had an inhibitory effect.



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Prefair Report

4115 **Victoria Lui**

Div/Cat **Life and Earth / Senior**

Title: **Aspirin for Radishes**

Summary: Acetylsalicylic acid is one of the most widely used drugs in the world. Its ancestry the salicylates, which includes salicin and salicylic acid, are found in willow and poplar tree bark and leaves. Acetylsalicylic acid is a combination of an acetyl group and salicylic acid, and dissolved into salicylic acid in water. All plants produce salicylic acid, and it functions as an important phenol phytohormone that controls the plant's immune response to infection. Therefore, my project investigated the effect of acetylsalicylic acid on *Raphanus raphanistrum* subsp. *sativus* (radish) growth. My research question is: How do varying concentrations of salicylic acid affect the height of plants? My null hypothesis is: There is no statistical difference between the concentration of aspirin used to grow the plant and the height of the plant. my alternate hypothesis is: The concentration of acetylsalicylic acid acid affects the height the plant grows to. After experimentation, I concluded that there is a statistical difference between the height of the radishes and the concentrations of acetylsalicylic acid used to grow them, and that there was an optimum concentration that allowed maximum growth. This project has many applications to plant immunity and immunity in general, since there are many SA binding targets within plants and humans.



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