**Alternate Hypothesis:** If the pH of the sunflower extract is high (above 7) than less sunflower seeds will germinate, and root lengths will be shorter.

**Null Hypothesis:** If pH level is altered than the germination rates and root lengths will not be affected.

**Materials:** 14 Petri Dishes, 140 sunflower seeds, 5 fully grown sunflowers, pH tablets, 2 sets of a Mortar and Pestle, Cheese Cloth, 40 filter paper, 4 jars to hold extracts, 5mL pipette and pipette tips, light source, and a Caliper.

**Techniques:** Observing allelopathic effects of pH by measuring root length of germinated seeds

**Methods:**

To commence the experiment, gather the necessary materials. Obtain 15 sunflower leaves which will be used to create the sunflower extract. Cut the sunflower leaves into tiny pieces and place them into a mortar. Add 160 mL of distilled water to the mortar. Use a pestle to grind the sunflower leaves until the water becomes the color of the leaves. Obtain a clean beaker and place a piece of cheesecloth over the beaker. Pour the liquid within the mortar over the cheesecloths so that it filters into the beaker. Label the beaker “sunflower leaf extract” and set it to the side. Grab a clean mortar and 15 more sunflower leaves. Cut the sunflower leaves into tiny pieces and place them into the clean mortar. Add 160 mL of distilled water to the mortar, as well as, an acidic pH tablet. Use a clean pestle to grind the sunflower leaves and the pH tablet until the water is the color of the leaves. Obtain a clean beaker with a fresh piece of cheesecloth placed over the beaker. Pour the liquid inside of the mortar over the cheesecloth so that it filters into the beaker. Label this second beaker “acidic sunflower extract” and set it aside. Obtain a clean mortar and 15 more sunflower leaves and repeat the previous steps, grinding the sunflower leaves in 160 mL of distilled water. Instead of using an acid pH tablet, however, place a basic pH tablet into the mortar to be grinded with the sunflower leaves. Then, follow the previous steps to transfer the liquid within the mortar to a separate clean beaker. Label this third beaker “basic sunflower extract.”

Obtain 12 clean petri dishes. Spread three pieces of filter paper across the bottom of each petri dish. Place 10 sunflower seeds within each of the 12 petri dishes. Label three of the 12 petri dishes “distilled water.” Label another three “sunflower extract w/ distilled water.” Label another three “acidic sunflower extract” and the last three petri dishes “basic sunflower extract.” Using a pipette, pour 5 mL of distilled water into the three petri dishes labeled “distilled water.” Then, using a clean pipette tip, pour 5 mL of the sunflower and water extract into the petri dishes labeled “sunflower extract w/ distilled water.” Follow these same steps using the acidic sunflower extract and the basic sunflower extract to place into the petri dishes labeled “acidic sunflower extract” and basic sunflower extract,” respectively. Once all the 12 petri dishes are moistened with the correct extracts, place them under a light where they will grow for one week. Take what is left over of each extract and put them in separate jars that are to be refrigerated. The remainder of these extracts will be used to water the plants for the rest of the week. The plants are to be observed each day of the week and watered with the correct extracts when necessary. Record each day the number of seeds in each petri dish that have germinated and the condition of each sunflower plant. At the end of one week, measure the root lengths of all of the germinated sunflower plants.

**References:**

Bower, D., Morgan, D., Phillips, K., & Roeth, B. (2005, May 20). The Effect of pH on the Growth of Green Beans. Retrieved from <http://jrscience.wcp.muohio.edu/nsfall05/LabpacketArticles/TheEffectofpHontheGrotwho.html>

* We were able to look at how another lab did a similar experiment with green beans. We saw their thought process and their steps taken. Low pH values could create a nutrient deficiency in the cells and could cause the plants to die.

Sripad, G., Prakash, V., & Narasing, M. S. (1982, June). *Extractability of polyphenols of sunflower seed in various solvents*[Scholarly project].

<https://link.springer.com/article/10.1007/BF02702723#citeasv>

* We were able to see that there is a chemical called chlorogenic acid in sunflower seed that helps to regulate pH values. This chemical can be extracted from the sunflower seed with the assistance of another chemical.

Perry, L. (2003). PH for the Garden. Retrieved from <http://pss.uvm.edu/ppp/pubs/oh34.htm>

* From this article the author posted several different pH of the soil of surrounding plants. This can be used to compare natural soil type.

Raya-Díaz, S., Quesada-Moraga, E., Barrón, V., Campillo, M., & Sánchez-Rodríguez, A. l02saroa@uco. e. (2017). Redefining the dose of the entomopathogenic fungus Metarhizium brunneum (Ascomycota, Hypocreales) to increase Fe bioavailability and promote plant growth in calcareous and sandy soils. *Plant & Soil*, *418*(1/2), 387–404. <https://doi.org/10.1007/s11104-017-3303-0>

* They added different doses of EF and tested the affects on sunflower growth but also found that it affected the pH levels in the sunflower.

Lasa, B., Frechilla, S., Aleu, M., González-Moro, B., Lamsfus, C., & Aparicio-Tejo, P. M. (2000). *Effects of low and high levels of magnesium on the response of sunflower plants grown with ammonium and nitrate*(1-2 ed., Vol. 225, Rep.). Retrieved from <https://link.springer.com/article/10.1023/A:1026568329860>

* This focuses on the effect of different levels of magnesium on plants. This will help us compare the effects of other chemicals that affect pH level in sunflowers.

<https://pubs.acs.org/doi/abs/10.1021/jf049612j>

* A study on how heat and pH work hand and hand to affect growth on the sunflower.

https://homeguides.sfgate.com/ph-affect-plants-49986.html

* How pH levels normally affect plants. It can affect the plants ability to absorb nutrients.

<http://plantsinmotion.bio.indiana.edu/plantmotion/earlygrowth/germination/sunflower/sun.html>

* Video on seed germination (maybe for presentation)