WISEST
women in scholarship, engineering, science & technology

UNIVERSITY OF ALBERTA

Canada

Aeroponic Potato Pot

Blaire Buchan, Dr. Rafiq Ahmad, Rabiya Abbasi

August 16, 2021

Blaire Buchan

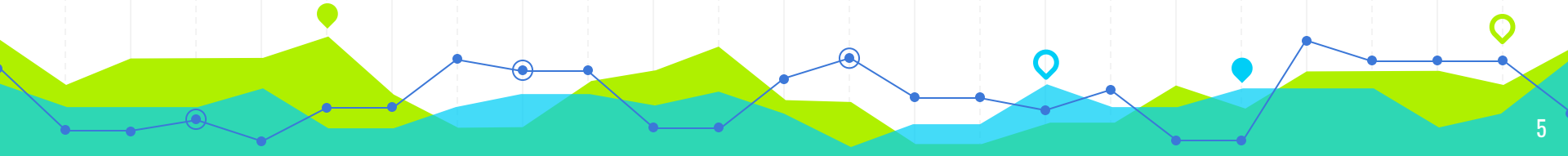
Student Researcher in LIMDA for my placement in the 2021 Summer Research Program

Abstract

For my project in the 2021 Summer Research Program I designed an aeroponic potato pot. The task given was designing a small aeroponic pot that could be used domestically and tuber roots (ex: yam, potato) were going to be the niche purpose for the aeroponic pot. This choice was made because when gardening tubers it is common to lose some of the underground crop either from not digging it up or damaging it while digging it up but in aeroponics the root is exposed therefore harvesting would be more efficient. Potatoes were the specific crop decided on for research because of their versatility and how common potatoes are in people's diets. By the end of the Summer Research Program the design for the aeroponic potato pot had been 3D modeled.

What is Aeroponics

Aeroponics is a technique used for growing plants where the roots of the plant is suspended in the air and a fine mist of water and nutrients is periodically sprayed on the roots to maintain moisture and feed the plant.



Why is Aeroponics Important

The earth has limited amounts of freshwater available for consumption and 70% of usable freshwater is used for agriculture and 40% of that water used for agriculture is wasted from runoff, evaporation or careless handling (Albert, 2021; Balsom, 2020).

In aeroponics 70% less water is used compared to traditional farming (Despommier, 2019) because runoff and evaporation does not happen in a contained, controlled environment. Meaning there will be more water available for human consumption.

My goal is to make harvesting potatoes easier and more water efficient

I created a design that is small scale so that it could be used inside the home and there is no dirt involved so harvesting the potatoes will be easier and cleaner. The water will also be contained and because it is aeroponic, less water will be lost during the watering process. As of now the available aeroponic method for potatoes is a large scale setup used in mass farming production (Tunio, 2020) and any small scale aeroponic planted is not usable for tuber plants (Poliziani, 2020). Any viable method for potato planting inside of a home involves dirt and therefore a mess.

Design Process

Research Phase

After I was given the outline for what I was to do for my project I decided on my goal and researched from there. Aeroponics is relatively new so not a lot of research is done on the topic and when it comes to aeroponics specifically regarding potatoes the research was few and far between. All of the papers on aeroponic regarding potatoes were about mass seed/potato production for large farms (Filho, 2020) . Most of the aeroponic setups the research papers referenced equipment that was not viable for what I wanted to accomplish (Filho, 2020), water flow was regulated with large machines that could not be used in a domestic setting. I also struggled with finding research on small pumps that I could use which would create enough pressure to mist the water for the potatoes.

Design Process

Planning Phase

Potatoes were chosen for this design because of the lack of research regarding potatoes considering how commonly potatoes are used domestically. After affirming potatoes were going to be used for the design purpose research into potatoes themselves and what they need to grow was conducted. Based on potatoes needs, the lack of research and prior knowledge, brainstorming lead to a solid outline design that would function as an aeroponic pot for a potato.

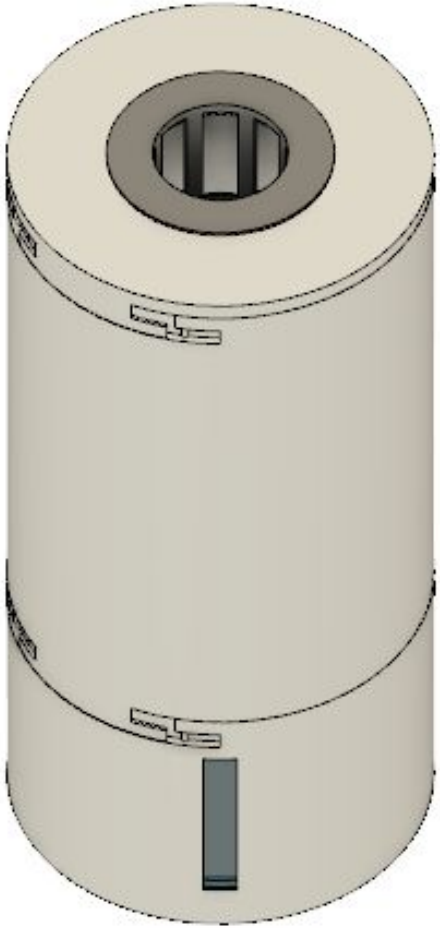
Design Process

Designing Phase

The biggest challenge in designing the potato pot was finding the right program that I could get access to for 3D modeling. The program I ended up using was Autodesk Fusion 360 and it took time to be able to use the program effectively. During building the base design many small details had to be researched further, for example the connection design between the components originally looked different but they were changed for more security. Some of the design came came from personal experience such as using a pump commonly being used for spraying on a field came from my farm experience background.

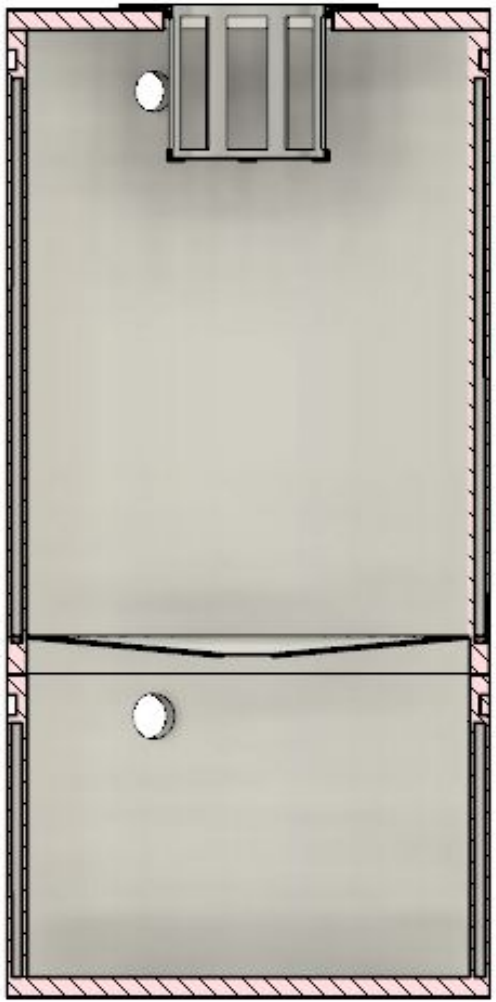
Potatoes

The biggest thing I had to take into account for the design was that potato roots need to be kept cool and need to be in a dark environment (Tunio, 2020) which is why a vacuum seal was incorporated around the borders and an opaque plastic material was used for the design. Based on the average sized potato plant in my garden the root compartment is 16” with a radius of 6” the best fit the plant without being to big or small. A major design flaw is that I do not have a built in measure for the nutrients (varies with each breed of potato) or pH (under 7.3 (Tunio, 2020)) but since an array of potatoes can be planted it is up to the user to know what their potato needs.

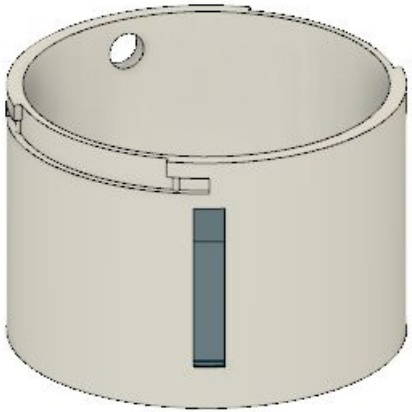


Overall Design

This is the overall design of the aeroponic pot. The radius is 6” an the total height is 24.6”. There is a vacuum seal around the water compartment and the root compartment to control heat exchange. The holes are for the water hose that will transfer water with a small diaphragm pump attached in the back. In the root compartment, the hose will have a misting nozzle on the end to water the plant that will water the plant at a downward pointing angle.



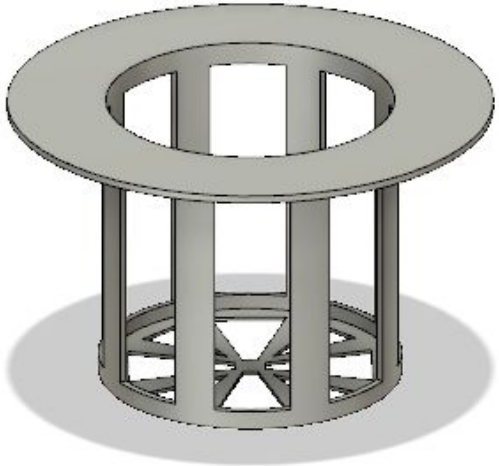
Components



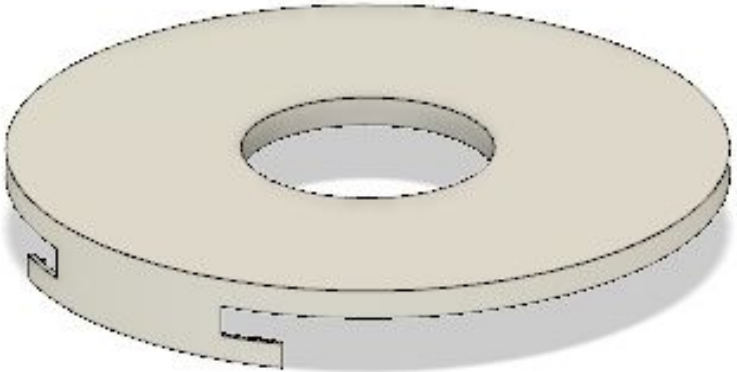
Water compartment: this is where the nutrient water will be stored. The height is 8”. There is a glass window in the front to measure water level.

Root compartment: this is where the roots will hang in the air. Inside the compartment there is a funnel that will allow water residue to fall back into the water compartment.

Components



Potato cup: This holds the potato seedling and allows the roots to grow out of the holes. The radius is 2” and the height is 4”.



Lid: Used to prevent light and bugs from gaining access to the roots.

Mechanical Design

One of the small details in the mechanical design is the empty space between the inside wall and outside wall. This is to create a vacuum seal so that heat will not be able to transfer as efficiently as it would with a solid wall. I did this so that the potato roots would stay as cool as possible while the outside environment is at room temperature. The other finer detail is the connection between each level. I have designed it so that the connection could happen in either direction and that if you were to lift a compartment it would not separate until you moved the components rotationally from each other.

Electrical Design

For the Aeroponic potato pot to be functional a water pump needs to be used to pump the water from the bottom compartment to the top and have enough water pressure to be able to force water through a misting nozzle so that the nutrient water is misted onto the potato roots for the optimum root absorption. Unfortunately I was unable to find a specific pump to incorporate into my design but my design is most suited for a small diaphragm pump. The other electrical component for my design is a timer to control the spray intervals for watering. Because of the lack of research I had a hard time finding products tailored to my design so more research and experimentation is needed.

Future Work

Although this design is well thought out simulations were not run on water flow and suitable products to use in the design were not found. Before creating prototypes experiments with different types of pumps is needed to find the most effective one. Simulations on water flow through different misting nozzles is another requirement to take this design farther, nutrient water does commonly clog in aeroponic water systems so this is an important part to simulate (Despommier, 2019). Easier access to the root chamber is another improvement that could be implemented on this design because how the design is currently structured lifting up the lid is the only way to access the roots.

Conclusion

My goals of wanting to make potatoes easier to harvest and more water efficient have succeeded in theory but I can improve on the design. The size of the root compartment gives the potatoes plenty of space to grow and because the potatoes are not hidden in soil a person could harvest them by picking a few each day and leaving some still on the root instead of the traditional way of digging the entire plant up at once. Since this in an aeroponic system the roots will be directly consuming the water and as long as the electrical works as intended no water will be lost. There is no other design like this available but hopefully in the near future aeroponics will be more available to the general public.

Acknowledgments

The WISEST Team

Principal Investigator:

Dr. Rafiq Ahmad

Supervisor:

Rabiya Abbayi

Sponsors:

Google

Canada Summer Jobs

Citations

Dickson Despommier, « Vertical farms, building a viable indoor farming model for cities », *Field Actions Science Reports* [Online], Special Issue 20 | 2019, Online since 24 September 2019, connection on 06 August 2021. URL : http://journals.openedition.org/factsreports/5737

Mazhar H. Tunio, Jianmin Gao, Sher A. Shaikh, Imran A. Lakhiar, Waqar A. Qureshi, Kashif A. Solangi, Farman A. Chandio. Potato production in aeroponics: An emerging food growing system in sustainable agriculture forfood security. Chilean journal of agricultural research, vol.80 no.1 Chillán Mar. 2020. http://dx.doi.org/10.4067/S0718-58392020000100118

Albert, J.S., Destouni, G., Duke-Sylvester, S.M. *et al.* Scientists' warning to humanity on the freshwater biodiversity crisis. *Ambio* 50, 85–94 (2021). https://doi.org/10.1007/s13280-020-01318-8

Poliziani, M. (2020). Indoor aeroponic tower for a stable food self-production. https://www.politesi.polimi.it/bitstream/10589/170089/3/Indoor%20aeroponic%20tower%20for%20a%20stable%20food%20self-production.pdf

Jaime Barros da Silva Filho, Paulo Cezar Rezende Fontes, Paulo Roberto Cecon, Jorge F.S. Ferreira, Milton E. McGiffen Jr., Jonathan F. Montgomery. Yield of Potato Minitubers under Aeroponics, Optimized for Nozzle Type and Spray Direction. HORTSCIENCE 55(1):14–22. 2020. https://doi.org/10.21273/HORTSCI13971-19

Zoran BROĆIĆ, Mirko MILINKOVIĆ, Ivana MOMČILOVIĆ, Dobrivoj POŠTIĆ, Jasmina OLJAČA, Biljana VELJKOVIĆ, Drago MILOŠEVIĆ. PRODUCTION OF POTATO MINI-TUBERS IN THE AEROPONIC GROWING SYSTEM. Original Scientific Paper, 1821-4487 (2018) 22; 1; p 49-52. 532.pdf (bg.ac.rs)

Imran Ali Lakhiar, Jianmin Gao, Tabinda Naz Syed, Farman Ali Chandio & Noman Ali Buttar (2018) Modern plant cultivation technologies in agriculture under controlled environment: a review on aeroponics, Journal of Plant Interactions, 13:1, 338-352, DOI: 10.1080/17429145.2018.1472308

Paul Balsom. (2020) Water Usage In The Agricultural Industry, High Tide Technologies. https://htt.io/water-usage-in-the-agricultural-industry/