Student Spaceflight Experiments Program

A program of the
National Center for Earth and Space Science Education (NCESSE)
and the Arthur C. Clarke Institute for Space Education

SSEP Flight Experiment Proposal
SSEP Mission 12 to the International Space Station

Can Yarrow germinate in microgravity?

Grade Level(s) of Submitting Student Team: 5/6
Submitting School: Wolseley School
Submitting School District: Winnipeg School Division, Winnipeg, MB, Canada

Submitting Teacher Facilitator
Name: Suzanne Mole
Position: Principal Wolseley

The question we are focusing on for our experiment is whether Yarrow seeds will germinate in microgravity. We decided to focus on Yarrow seeds because Yarrow is a traditional Manitoba plant that can be used for different types of medicine. We learned through our research that Indigenous people used Yarrow to cure headaches, toothaches, and stomach issues. We think that the Yarrow can help the astronauts on the space station because if they can grow Yarrow in space then they can grow their own medicine.
Our Experiment will use two of the FME 3 Mini Labs- one for on the space station and one for our control experiment here at school. In our experiment, we are going to place ten seeds

harvested from our school garden into Rockwool in Volume 2 of the mini lab. On the second day in space, we will have the astronauts unclip the clamp and add 3 ml of distilled water. We asked NASA staff about the temperature of the Space Station and were told that it was 22-25 degrees Celsius. We know that in temperatures such as this it takes Yarrow 14-28 days to germinate. We have planned to have the astronauts release the second clamp and add 3 ml of the fixative 10% Neutral Buffered Formalin to the growing seeds on day 31. This will preserve the seeds at exactly that time so that we can compare these seeds with the seeds from our control experiment to decide whether Microgravity affected germination of the seeds.

II. Student Team Members Page

Co-Principal Investigators:

Name: Betty Ngo
Grade level: 5

Name: Emelia Stephenson
Grade level: 6

Name: Kiara Dayson
Grade level: 5

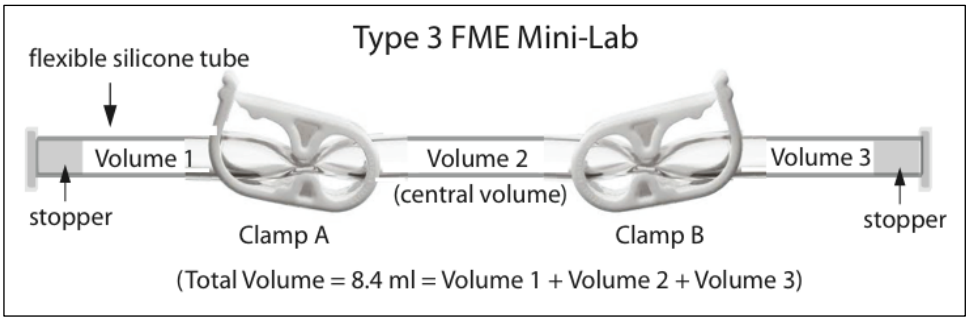
Name: Madeline Stewart
Grade level: 6

Name: Sariah Dayson
Grade level: 6

III. Experiment Materials and Handling Requirements Pages

1. **Fluids Mixing Enclosure (FME) Type Proposed to be Used (check one):**
   X Type 3 FME (3 experiment volumes: two clamps used)

2. **List of Proposed Experiment Samples (Fluids and Solids to be used)**
   - 2 cubic centimeters of Rockwool, 3 ml of distilled (bottled) water, 10 Yarrow seeds, 3 ml of Formalin



Volume 1
List each fluid/solid to be used and the amount of each sample:
3 ML Distilled/Bottled Water

Volume 2
List each fluid/solid to be used and the amount of each sample:
2 square centimeters of Rockwool
10 Yarrow Seeds

Volume 3
List each fluid/solid to be used and the amount of each sample:
3 ML of 10% Neutral Buffered Formalin (NBF)

IMPORTANT: Are any of the proposed samples human in origin? (check one):
___ Yes
_X_ No

3. Special Handling Requirements During Transportation

None

4. Proposed Timeline of Crew Interactions – Your Proposed Crew Interaction Days and Crew Interactions Aboard ISS

A + 2: Unclamp Clip A Shake gently for 30 seconds

U - 2: Unclamp Clip B Shake gently for 30 seconds

Table 4: Timeline of Crew Interactions

Allowed Crew Interaction Day	Requested Interaction
A=0	
A+2	Unclamp Clamp A, shake gently for 30 seconds
U-2	Unclamp Clamp B, shake gently for 30 seconds

IV. The Question to be Addressed by the Experiment

Our question is whether Yarrow picked from our School garden will germinate on the space station. Our experiment needs to happen in space because if Yarrow can grow in microgravity in space, then it means that astronauts could possibly grow their own medicine. Then if there are any medical problems, they will hopefully be able to use Yarrow for a cure.

Since our question is whether Yarrow seeds will germinate in space, we will need to compare the seeds in our control FME on Earth and the FME on the Space Station. During the spaceflight, we will simulate all of the conditions in space (darkness, temperature, water, fixative). The only variable in the SSEP mini lab will be microgravity. If the seeds germinate, there is potential for herbal medicine to be harvested in space. (To double check the viability of the seeds we are using we will also grow 10 seeds in Rockwool on earth with sunshine and water- (giving the seeds everything we know seeds require for growth)

Our question came about as we researched the needs of astronauts as they live on the space station. We also know that there is a possibility in the future that the space travel could be longer than a year. We wondered what people on the space station do if they are sick? How they prepare for the illnesses, we on earth take for granted. We began to research traditional medicines and Yarrow was a plant that had multiple medicinal uses. (We felt that if the seeds were able to germinate in space then there was a

real potential to grow a plant that with a very small amount of processing could provide members of the space station with medicinal properties.)

Common Yarrow or (Achillea Millefolium) is a plant native to Manitoba that has flat clumps of white flowers and ferny leaves. It is fast growing and grows in forests, prairies, mountains and in our very own school garden. Its usual germination time is 14 to 28 days if grown in warm temperatures. Cited from: http://hollowreedholistic.ca/content/yarrow-herb

To harvest Yarrow you cut the flowers where the flower attaches to the stem. The leaves can be harvested by removing them from the stems. The Yarrow should be dried to store and for use in medicines. It is dried by using a dehydrator or by spreading the leaves, flowers, seeds on a cookie sheet and drying them in the oven at a low temperature for ten to fifteen minutes.

Indigenous peoples of Manitoba used Yarrow for traditional medicines. They chewed the stalks to break fevers, and pounded the stalk into a pulp and applied it to bruises, sprains and swollen body parts. They also used it as a digestive aide when they had stomachaches.

Today herbal medicine experts use Yarrow to treat some of the same problems as Indigenous healers. They create teas and tinctures (like creams) to heal deep wounds, headaches, common colds, and hay fever. Chewing on a fresh leaf is known to help the pain of toothache. Cited from: https://wellnessmama.com/7106/yarrow-herb-profile/

The medicinal parts of a Yarrow plant that help cure these illnesses and pains are “Flavonoids” Flavonoids are found in many fruits and veggies. They are plant-based metabolites that give health benefits to the people who use them. Flavonoids are also important antioxidants and provide the following benefits- they are anti-viral, anti-cancer, and anti- inflammatory and anti-allergic. They are known to strengthen blood vessels to heal bruising. There is also some evidence that Flavonoids can work to improve metabolism aiding in both maintenance of weight and in slowing the process of Diabetes in some people. Cited from: https://www.news-medical.net/health/What-are-Flavonoids.aspx and http://www.whfoods.com/genpage.php?tname=nutrient&dbid=119

A potential continuation for this experiment would be to test Yarrow plants grown in microgravity against those grown on earth to determine if the amount of available Flavonoids remains the same in both plants.

V. Experiment Design

When we began to think about putting a project into space we first thought about what things from earth Astronauts might need in space- food, water, health and exercise. We thought about all of the months that an Astronaut could be in space and how they might heal themselves if they become sick. That is when we began to think about natural medicines in plants- even plants that grow nearby.

In our experiment, we are going to place ten seeds harvested from our school garden into Rockwool in Volume 2 of the test tubes. On the second day on the space station, we will have the astronauts unclip clamp A, and add 3 ml of distilled water. Because we asked NASA staff about the temperature of the Space Station and were told that it was 22-25 degrees Celsius and we know that in temperatures such as this it takes Yarrow 14-28 days to germinate. We have planned to have the astronauts release the second clamp and add 3 ml 10% Neutral Buffered Formalin (NBF) to the growing seeds on the second last day in space to give the seeds the most time possible for germination.

Formalin is an organic liquid form of formaldehyde. In this experiment, we will use 10% Neutral Buffered Formalin (NBF) - which is Formaldehyde mixed in a salty water. It is being used to preserve the seeds in as natural, life-like state as possible. We chose NBF as our fixative as it preserves products in as close to a natural state as possible. (Cited from: https://www.labce.com/spg572647_formalin_fixative.aspx)

If we are to compare the seeds on earth to the seeds flown in space, we need them to be preserved quickly so that we can determine how many seeds germinated and if they have germinated- how much growth has occurred in the growing time allowed during the SSEP flight. We will compare "growth" by examining the seed coat for Imbibition (water in the seed), cracks in the seed coat, and evidence of root or shoot development.

Experimental materials

- 10 Yarrow seeds
- 2 cubic cm Rockwool
- 3 ml distilled water
- 3 ml NBF (fixative)
- Tweezers
- microscope/ magnifying glass
- camera/ipad

We harvested the Yarrow seeds from our own school garden. To ensure that the seeds were viable or alive we placed them onto wet Rockwool to see if they would begin to grow. We got

the Rockwool from our expert, Louise Shactay, who recommended it because Rockwool absorbs the water. We also researched Rockwool online: https://www.youtube.com/watch?v=LxF-fBNtaY0, and https://www.hydroponics.net/learn/rockwool.php (In doing this test we found that Rockwool dries out really quickly and is best at holding water when in a closed container like the FME Mini Lab)

We purchased the distilled water at a local store.

Experimental Procedure:
Our experiment has 3 steps. Set up of 2 FME labs, experimental process on earth and on the space station, data collection (examination of labs) from the FME lab on earth as well as the space station.

- 1 set up of the 2 FME mini labs
- We need to prepare 2 identical FME labs one too be flown on the ISS in microgravity
- The second FME lab will be kept in our classroom in the dark (because the other FME will be in complete darkness on the space station)
- We will make sure that both FMEs will be kept at the same temperature

Preparation of mini labs

1. We will embed ten Yarrow seeds into the 2 cubic cm of Rockwool
2. We will open the stopper at the end of Volume 1.
3. We will unclip Clamp A
4. Using Tweezers we will insert the cubes with the seeds into volume 2
5. Re Clip clamp A
6. Using a syringe we are going to place 3 ml of distilled water into volume A
7. We are going to put in the stopper at the open end of volume 1
8. Using a clean syringe we will insert the 3 ml of formalin into volume 3
9. Put in the stopper into the open end of volume 3.

We will repeat all nine steps for the FME lab here on earth.

Ground Elements:

On the ground, we will be having two sets of Yarrow seeds growing. One set will be given everything we know seeds require for growth including sunlight, water, Rockwool, and warmth. The other "control" experiment will have the all of the identical properties of the FME that is in space. We will control the water, the fixative, the seeds, and the temperature so that the only variable between the two is Microgravity. We will replicate all of the processes at school that we are asking of the astronauts in the space station.

Experimental Analysis:

Thinking back to our question, "**Will Yarrow seeds germinate in microgravity**"? We will need to find the answer by comparing and contrasting the two FME mini labs. We will be examining the seeds to get the following information:

- We will photograph the seeds from both FME labs to examine and compare the germination rate and development of the seeds.
- Differences we will be looking for include:
    - Differences in imbibition (big word for seeds soaking up water) We would see this in the size of the seeds as they grow and swell with water
    - Any cracks in the seed coat
    - Any growth of the plant embryo inside of the seed
    - Any growth of roots or shoots (measured with ruler)
- We will count the number of germinated seeds in both FME mini labs. Our prediction is that given the lack of sunshine in both Mini labs that only 50% of the seeds will germinate. We feel that microgravity will affect the germination rate- and that slightly less will germinate on the ISS than in the control FME on earth.
- We will also look at the two sets of seeds under a microscope at school to see any differences in the swelling or seed coats of both samples
- We will also examine both sets of seeds to note any differences in their growth and development. This would include the formation of roots, and the embryo forming a shoot which would grow out of the seed coat. We know that seeds further along germination would have had to germinate more quickly. If either sets of seeds is clearly further along in development then we know microgravity has either a positive or a negative effect on germination.

Extension:

- Once we have gathered this information and know finally if microgravity affects germination or not, we would like to suggest an extension to this experiment. Our extension would have Yarrow plants grown on the ISS so that we could examine the amount of flavonoids available in plants grown in microgravity as compared to plants grown on earth.

VI. List of Reference Publications

"Information on Yarrow". Retrieved November 3 2017 from Hollow Reed Holistic Website: http://hollowreedholistic.ca/content/yarrow-herb

"Information on Yarrow". Retrieved November 3 2017 from Soft Schools Website: http://www.softschools.com/facts/plants/yarrow_facts/669/

"Information on how to make Yarrow Tea". Retrieved November 3, 2017 from Edible Wild Foods Website: http://www.ediblewildfood.com/yarrow-tea.aspx

"Information on Flavonoids". Retrieved November 3, 2017 from WH Foods Website: http://www.whfoods.com/genpage.php?tname=nutrient&dbid=119

"Information on how to make Yarrow Tea". Retrieved November 3, 2017 from Wellness Mama Website: https://wellnessmama.com/7106/yarrow-herb-profile/

"Information on how to make Yarrow Tincture". Retrieved November 3, 2017 www.growingupherbal.com/freshYarrowtincture (how to make a tincture out of Yarrow)

"Information on Flavonoids". Retrieved November 3, 2017 from Medical. Net Website: https://www.news-medical.net/health/What-are-Flavonoids.aspx

"Information on Rockwool". Retrieved November 3, 2017 from Hydroponics.net Website: https://www.hydroponics.net/learn/rockwool.php

"Information on how to start plants with Rockwool". Retrieved November 3, 2017 from Hydroponics Video: https://m.youtube.com/watch?v=Lxf-fBNtaYO

"Information on Fixatives/Formalin". Retrieved November 3, 2017 from Labce Website: https://www.labce.com/spg572647_formalin_fixative.aspx