determine the feasibility of a full super food vegan diet grown in hydroponics for Mars exploration as a possibility for NASA and Space X food source problem.

Project HOME: Hydroponic Operations for Mars Exploration

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Rosa Polonia, R.A., Mitchell, T.J.

Department of Humanities and Communication, Embry-Riddle Aeronautical University

Statement of Problem

While NASA, Space X and likewise companies are all working hard to send a crew of astronauts to explore Mars, food source is one of the problems that have delayed this mission. As of today, crews that are sent to the space mostly eat pre packed food; however, these operations are usually for short period of time. For Mars Exploration the crew will be exploring for a year or more which is why necessary to find a way for the crew to grow food in Mars. Needless to say that continuously shipping food to space is not cost effective for these companies.

Objective

Determine the feasibility of a full super food vegan diet grown in hydroponics under reduced lighting for Mars exploration as a possible solution for NASA and Space X food source problem.

Preliminary Results

M. Oleifera was tested in a hydroponic system under Mars ambient lighting conditions of 590 W/m^2 for a full year. The plant tolerated repeated stem cutting (n=20), with rapid regrowth. A dry leaf yield of 0.224 g/day per plant was observed. This yield and the significant nutrient content of M. Oleifera are of interest, representing the production of significant food value shown in the table below, per the USDA reference data for M. Oleifera's nutritional content.

Nutrient	Amount Humans Require Per Day	Value Per 1g of Dry M. Oleifera Leaves	Amount of Dry Leaves Needed to Meet Human Needs [g]	Amount of M. Oleifera plants to produce required amount of dry leaves
Protein [g]	51	0.094	542.55	121.74
Energy [calories]	2000	64	31.25	7.01
Potassium, K [mg]	3500	3.37	1038.58	233.03
Calcium, Ca [mg]	1000	1.85	540.54	121.28
Vitamin A [µg]	900	3.78	238.10	53.42
Vitamin C [mg]	400	0.517	773.69	173.60

Introduction

Agriculture in enclosed structures on Mars enables astronauts to conduct extended surface exploration missions. To support these missions, we will evaluate multiple hydroponics systems to grow a complete necessary set of amino acids, vitamins, minerals, fiber, carbohydrates, and nutrients for a balanced diet. The hydroponics systems will be designed in a greenhouse powered solely through solar panels, and the plants will receive the same solar irradiance as the surface of Mars.

Moringa Oleifera and Goji Berries

Figure 1: Dutch Bucket System and Tower Garden

The Dutch Bucket System is used for the Moringa Oleifera. The nutrient dense water travels from the reservoir to the buckets then back to the reservoir.

The Tower Garden is used for the Goji Berries, Kale and Elderberries. This hydroponic system allows the plants to grow upwards without any interference.

Research Team

Team: Deanna DeMattio, Benjamin Hufendick, Katana Cohen, Nadia Meyer, Sadie Powe, Ila Dionne, Nick D'agrella

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Methodology

1. Use a shade tent to cover the greenhouse and solar panels so only 590 W/m^2 of sunlight is received by both the plants and solar panels.
   a) 2 Jinko Solar Panels will be placed on the ground optimizing sunlight
2. Use four hydroponic systems to save water and efficiently monitor the growth of plants.
   a) Vertical Tower – Goji Berries, Elderberries and Kale
   b) Raft System – Sweet Potatoes, Bok Choy, Ginger, Blueberries
   c) NFT Table – Kale
   d) Dutch Bucket System – Moringa Oleifera
3. Use iMonnit Wireless Sensors and Blue Lab Monitor to get 24/7 measurements of temperature, humidity, CO2, sunlight and pH.
4. Grow for 1 year with incremental harvests to determine the amount of growth for that period.
   a) Plants will be dehydrated then weighed to record an accurate measurement of weight/growth
5. Compare growth and weight with the USDA Food Composition Database to determine nutritional content of the plant grown.

Greenhouse and the Team

Figure 2: Ladybugs are being use for aphids and white flies infestion. The research team taking measurements of the harvesting. From the moringa olifeira