FOOD FOR EXTRA-TERRESTRIAL ASTRONAUT MISSIONS ON NATIVE SOIL.

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Introduction: Food demand and the lack of plant nutrients are the main reasons to establish a sustainable agricultural ecosystem on celestial bodies, such as Mars and the Moon. Different kinds of fresh crops, grown in a greenhouse, deliver essential macro and micro nutrients, which have a positive impact on the well-being of humans. Thus, they will also heavily influence the social interactions of future astronauts. Food development is therefore one of the main activities that will need to be established as soon as possible upon the landing of a human-led mission on another planetary body.

In addition, crops can be used for air purification and thus oxygen production. Experimental research has been conducted, during a two-week analogue astronaut mission (EMMIHS-II: the second of the Euro-MoonMars-IMA-HI-SEAS missions), to grow crops, from garden cress seeds, sown in soil that resembles the regolith on Mars and the Moon. This plant was used because it is easy and fast to grow, which is a priority for research projects during these short-duration missions. In addition, this research will help in reducing compost and fertilizer payloads for upcoming space missions involving human crewmembers.

Methodology: In a remote volcanic region in Hawai'i, United States, the geology and therefore its soil is quite similar to the regolith on Mars and the Moon. For these reasons, the Hawai'i Space Exploration Analog and Simulations (HI-SEAS) habitat was constructed and is being used in this area for space-related research purposes.

In this habitat, a greenhouse setting had been built with basic requirements for plant growth. The local soil in each of the 70 pots had pre-determined ratio's with a compost mixture: 0%, 1%, 2%, 3%, 5%, 10%, 25%, 50%, 75%, 100%. For these settings, the assumption was made that shielding from Solar Energetic Particles (SEP) and Galactic Cosmic Rays (GCR's) was present. These types of radiation, and thus shielding from the radiation, would be of high relevance on Mars and the Moon to protect the crops there from malformations and death. Future habitats may be located in lava tubes or covered by regolith to address these requirements (Fig.1).

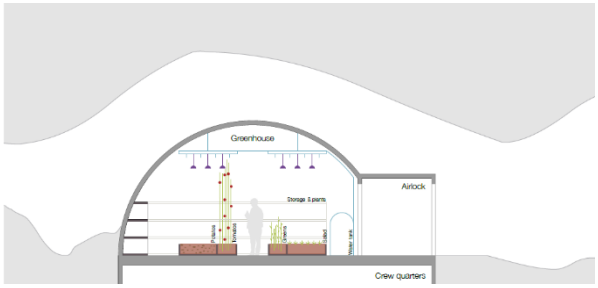

Fig. 1: Sketch of a greenhouse in a lava tube habitat [1].

Here, the presented results focus on the needed ratio of compost to 'Martian' simulant soil for garden cress. The results indicate that coarse 'Martian' soil with 2% of compost is sufficient for establishing sufficient germination and plant growth in the first stage of plant development (Fig.2). This result leads to promising expectations for other nutrient-soil ratio experiments. In particular for the growth of potatoes and beans, as they are high in nutrients per m^3.

Fig. 2: Pictures of some of the garden cress grown during the EMMIHS-II simulation.

Studies on different kinds of soil ratio's, nutrients delivered per m^3, radiation shielding and the architecture of an indoor greenhouse setting are of significant relevance to future missions to the Moon and Mars, and thus deserve further investigation.

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References:

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