The Effectiveness of Biochar as an Amendment on the Growth of Raphanus sativus on MGS-1 (Mars Global Simulant) and the Development of a Model for Regeneration of Water and Oxygen for Life Support Sustenance on Mars

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Human survival and sustenance on Mars depend on sustainable agricultural practices and developing a life support system using in-situ resources. Martian regolith is sterile and devoid of organic matter. This study aims to understand the application of biochar as an amendment on MGS-1 with Earth soil at various substrate ratios to determine which substrate resulted in the survival and growth of Raphanus Sativus. The study also aims to develop a model to estimate the number of plants needed per day on Mars to regenerate water and oxygen to support human life. The initial analysis of the MGS-1 indicated it as alkaline and missing an essential nutrient, nitrogen, for plant growth in the regolith composition. Biochar, a carbon rich material formed through pyrolysis, was used to amend the regolith on various substrates for acidification, nitrogen fixation, microbe introduction, and water transpiration to aid plant germination and growth. Survival and harvest occurred at 0%, 45%, 55%, 60%, and 65% MGS-1. Significant differences existed between the control group and substrates for wet and dry biomasses of plants grown ($p<0.05$). This could be due to low water retention properties or aggregation of regolith with soil and biochar combinations, resulting in poor transpiration in the substrates. The model demonstrates the estimated number of plants to be 270 to 318 plants for air, 135 to 159 plants for water and 697 to 825 plants for oxygen per day. Results indicate that biochar can aid in plant growth and develop a life support system for space exploration.