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IN-ORBIT AUTONOMOUS LABORATORY FOR MICROGREENS CULTIVATION ON A
NANO-SATELLITE: GREENCUBE MISSION**Abstract**

Long-term space missions require an ECLSS (Environmental Control and Life Support Systems) able to recycle resources. Plants can be used to improve the ECLSS performances, as they can use organic wastes to produce fresh food and water. Moreover, they can contribute to the production of oxygen and to improve the psychological condition of the astronauts. After the completion of the first in-orbit cultivation with the Salyut-7 mission, new experiments are nowadays hosted in the Vegetable Production System (Veggie) on-board of the ISS (International Space Station) and on other orbital platforms. The

miniaturization of ECLSS and its efficiency are of key importance for the future space exploration long-term missions. Microgreens are considered the main candidate for orbital cultivation because of their optimal volume/nutritional ratio and for the small amount of water needed for the cultivation. Moreover, they were selected due to their high nutraceutical values and the high content of micronutrients, like Selenium and Magnesium, important in a balanced spaceflight diet. GREENCUBE mission is aimed at demonstrating the capabilities to grow microgreens in an autonomous cultivation laboratory to be hosted in a 3U CubeSat. It will equip all the monitoring and managing systems necessary to study and control the growth of 17 microgreen during a short life cycle (20 days). GREENCUBE will act as a small and autonomous plant cultivation laboratory hosted inside a pressurized vessel operating at 0.5 bar (50Kpa), provided with growing LEDs arrays for photosynthesis management, water, nutrients, a micro-pumping equipment, an air replenishment tank, a humidity and thermal control system and a capillarity growing substrate. To monitor the plants status, cameras, thermal camera, watering, and air composition (VOCs, O₂, CO₂) sensors are included in the ECLSS. The satellite is under development and it will be launched on-board the VEGA-C launcher vehicle as winner of a secondary payload launch opportunity for the VEGA-C Maiden Launch. This paper deals with the development and qualification of the GREENCUBE satellite ECLSS for plant microgreens cultivation. After presenting the satellite mission objectives, the ECLSS design and development will be described. A detailed overview of the needed functional and environmental tests for the ECLSS qualification is provided. The paper conclusions report the ECLSS applicability to future CubeSat missions and the extensions of the described research. The satellite is being developed by Sapienza University of Rome, University of Naples “Federico II” and ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development).