

Utilization of a terrestrial cyanobacterium, *Nostoc* sp. HK-01, in closed bio-ecosystems

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Cyanobacteria has been used as a traditional food resource in many parts of the world. Food production under severe conditions is important for life-support in closed bio-ecosystems.

A terrestrial cyanobacterium, *Nostoc* sp. HK-01 may be utilized for bio-chemical circulation in closed bio-ecosystems, including Mars. *Nostoc* sp. HK-01, has several ability; photosynthesis, nitrogen fixation and space environmental tolerance to drought, vacuum, heat, UV, gamma-ray and heavy particle beams. We propose the utilization of a terrestrial cyanobacterium, *Nostoc* sp. HK-01, as food in closed bio-ecosystems.

In this study, we verified the utilization of terrestrial cyanobacterium *Nostoc* sp. HK-01 as a food resource on Mars, and will discuss technology for recycling this strain as a food resource in a closed bio-ecosystem.

Keywords: closed bio-ecosystems, cyanobacteria, food resources, *Nostoc* sp. HK-01

Current Status on CELSS for Human Space Activities - An Introduction of ECLSS on board ISS -

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It is called ECLSS (Environmental Control and Life Support System) that provides suitable environment for human space activities. The smallest ECLSS is a space suit. On the other hand, ISS (International Space Station) has one of the largest ECLSS for long term stay. It looks like a very complicated chemical plant composed of several functions. Still, this ECLSS is a subset of fully CELSS (Controlled Ecological Life Support System). CELSS consists of air revitalization, food production, thermal control, waste disposal, and water recovery functions. The most important and difficult function is the food production. Current ECLSS on board ISS lacks this. However we can't have achieved this CELSS even on the ground yet. Anyway this ECLSS can keep the environment inside ISS comfortable, provide material requirement from human body, and process exhausting material from that. Let's introduce the ECLSS on board ISS as a step to the fully CELSS.

Keywords: CELSS, ECLSS

Utilization of the terrestrial cyanobacteria

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The terrestrial, N₂ -fixing cyanobacterium, *Nostoc commune* has expected to utilize for agriculture, food and terraforming cause of its extracellular polysaccharide, desiccation tolerance and nitrogen fixation. For isolation, many of bacteria, fungi, algae and cyanobacteria were obtained from natural *Nostoc commune* crusts. It may be suggesting that *Nostoc commune* has potential of "Cradle of Life". In this report, we suggest possibility of agriculture, using the cyanobacterium. Further, we also found radioactive compounds accumulated *Nostoc commune* (cyanobacterium) in Fukushima, Japan after nuclear accident. Thus, it is investigated to remove radioactive compounds from soil by the cyanobacterium and showed to accumulate radioactive compounds using the cyanobacterium. We will discuss utilization of terrestrial cyanobacteria under closed environment.

Keywords: desiccation, terrestrial cyanobacteria, bioremediation, agriculture, space agriculture

Evaluation of nutritional utilization of *Nostoc* sp. HK-01, as a food resource in closed bio-ecosystems

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We study life-support in closed bio-ecosystems to provide food and oxygen for habitation in severe environments. We propose several species of organisms as candidate species. A terrestrial cyanobacterium, *Nostoc* sp. HK-01 has several unique abilities, photosynthesis, nitrogen fixation and tolerance to a space environment. Here, we propose to utilize *Nostoc* sp. HK-01 as a food resource in space environments such as Mars. *Nostoc* sp. HK-01 appears to have high nutritional values for humans. We will discuss the nutritional utilization of *Nostoc* sp. HK-01 in closed bio-ecosystems. Our results may contribute to the supply of food resources under severe conditions for life-support in closed bio-ecosystems.

Keywords: closed bio-ecosystems, cyanobacteria, food resource, *Nostoc* sp.HK-01, nutritional utilization

Possibility of tree utilization in closed bio-ecosystems - Proposal research in model tree *Prunus* sp.

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Living creatures on the earth have evolved since their origin. They are equipped with several important functions affecting each other. Knowledge about these functions and interactions with the ecological factors is essential for secure design of a closed-ecosystem with a limited number of living species under severe environments, such as space and deep sea or desert. We have studied trees for using their materials in such environment. There are various utilizations of trees on the earth. Trees have numerous abilities such as materials for several tools in a closed bio-ecosystem. Japanese flowering cherry trees, *Prunus* sp., have been studied as one woody plants in our research group. We carry out experiments to show actual usage in a closed bio-ecosystem by using a small bonsai, CosmoBon, that is easy to use physiological experiments after the selection of suitable and perfect strains of the tree. We will discuss the biological and technical systems for the establishment of closed systems.

Keywords: Closed bio-ecosystem, CosmoBon, Space experiment, Severe environment, Tree utilization