

***Azolla* as a Dish of Space Diet for Habitation on Mars**

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For habitation on extraterrestrial planets, such as moon and Mars, bio-regenerative agricultural system is requested to support human life. We evaluated nutrition of a candidate menu designed for space agriculture. A combination of rice, soybean, sweet potato, green-yellow vegetable, silkworm pupa, loach and *azolla* was found to be an appropriate diet that fulfills the human nutritional requirements. Rice, aquatic fern *azolla* and loach will be co-cultured in rice paddies in order to enhance the productivity high under limited resources available for it. Symbiotic cyanobacteria in *Azolla* fix nitrogen, with rather quick response, at shortage of nitrogen fertilizer. *Azolla* is an effective green manure, and suppress germination and growth of weeds by covering water surface. Co-culture of fish or water bird makes further advantage of converting *azolla* and weed to animal meat, and upgrading biomass to edible food. Action of fish or bird in rice paddies brings other positive effects on rice production as well. In this study, we examined feasibility of taking *azolla* for human diet at space habitation, and the nutritional value of *azolla* menu.

As a nutritional reference, we chose the Standard of Foods Intake defined by the Ministry of Health, Labour and Welfare of Japan. In addition to target level of energy intake and each nutrient, the allowance level is recommended for many items. Besides the levels depend on age, sex and physiological state, we took the standard for an adult under normal activity levels.

Chemical analysis of *Azolla filiculoides*, cultivated by the IRRI medium, indicated 7kcal energy, 1.1g protein, 0.1g lipid, 0.4g sugar, 1.6g dietary fiber, 35.3mg Na, 22.5g P, 0.98mg Fe, 34.6mg Ca, 92.8mg K, 23.7mg Mg, 0.04mg Cu, trace Zn, 0.98mg Mn, 0.103mg Vitamin A (V-A) and 4mg V-C per 100g of its plant body. Nutrition of *azolla* is similar to that of alfalfa sprouts, or typical marine macro-algae. A model menu was designed as 300g rice, 120g soybean, 200g sweet potato, 300g green-yellow vegetable (Komatuna), 50g silkworm pupa, 90g loach and 100g *azolla* after the iteration to optimize the composition. This menu provides; 1995 kcal energy (100% of standard foods intake, same for following items), protein 142%, lipid 73%, carbohydrate 109%, K 288%, Ca 324%, Mg 247%, P 348%, Fe 278%, Zn 117%, Cu 147%, V-A 281%, V-D 144%, V-E 147%, V-K 1088%, V-B₁ 280%, V-B₂ 174%, niacin 198%, V-B₆ 214%, V-B₁₂ 320%, folic acid 400%, pantothenic acid 188%, V-C 180%, dietary fiber 209%, NaCl 4% and Mn 276%. Deficient NaCl is supplemented as cooking salt. The amino acids score was estimated to be 100%. The Protein : Fat : Carbohydrate ratio was 18.5 : 16.5 : 65.0, close to the ideal ratio.

The model recipe fills the nutritional requirement. Since space agriculture will be managed under the severe constraints, and intend to close the materials recycle loop as much as possible. Such feature of space agriculture is useful at scoping the sustainable civilization on the earth.