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Microorganisms applying for artificial soil regeneration technology in space greenhouses

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The space greenhouse and technology for growing plants are being designed in frame of bio-technical life support systems development. During long-term space missions such greenhouse could provide the crew with vitamins and rough plant fiber. One of the important elements of the plant cultivation technology in the absence of earth gravity is organization and support the optimum root area. The capillary-porous substrate composed of anionites (FIBAN -1) and cationites (FIBAN -22-1) synthetic salt-saturated fibers is developed for plant cultivation in space and named "BIONA-V3". The BIONA main features are high productivity and usability. But the pointed features are not constant: the substrate productivity will be decreasing gradually from vegetation to vegetation course of plant residues and root secretions accumulation. Also, the basic hydro-physical characteristic of root zone will be shifted. Furthermore, saprotrophic microflora will develop and lead to increasing the level of microbial contamination of whole inhabit isolated module. Due to these changes the substrate useful life is limited and store mass is increased in long-term missions. For overhaul-period renewal it' necessary to remove the roots residues and other organic accumulation providing safety of the substrate capillary-porous structure. The basic components of 24-days old plant roots (Brassica chinensis, L) are cellulose (35 %) hemicellulose (11 %) and lignin (10 %). We see that one of the possible ways for roots residues removal from fibrous BIONA is microorganisms applying with strong cellulolytic and ligninolytic activities. The fungi Trichoderma sp., cellulolytic bacteria associations, and some genus of anaerobic thermophilic cellulolitic bacteria have been used for roots residues biodegradation. In case of applying cellulolytic fungi Trichoderma sp. considerable decrease of microcrystalline cellulose has been noted in both liquid and solid state fermentation. Cellulolytic fungi weight has been increased up to 30 % from initial roots dry weight. When the bacterial association derived from organic compost was used, the roots dry weight reduction was not exceeded 20 % in liquid state fermentation after 21 days. But the total cellulose was quietly steady, only the readily accessible soluble fractions were consumed. It was found that the most promising microorganisms for pointed task are anaerobic, thermophilic bacterium Clostridium thermocellum F9 and Caldicellulosiruptor bescii DSM 6725. It has been shown that its' in the liquid medium with the roots residuals during 10 days provides root biomass degradation up to 45 % and double decrease of crystalline cellulose. It's known that one of the possible ways to improve biodegradation process efficiency is applying of physical-chemical pretreatment for plant biomass. We used the pretreatment of BIONA substrate in microwave irradiation in 0,7 % sodium hydroxide water solution with addition of 0,5 % of hydrogen peroxide. It has allowed hydrolyzing the roots biomass partially and making the cellulose portion accessible to subsequent biodegradation. The alkaline pretreatment and the subsequent degradation by anaerobic, thermophilic bacterium Clostridium thermocellum, had lead to root biomass decrease up to 85% during 10 days. The examined procedure has allowed to restore the initial pore space volume of BIONA substrate and its' hydro-physical properties. It has made used-up BIONA suitable for the subsequent plant cultivation. The obtained results are the basis for future development of fibrous artificial soils regeneration technologies particularly for space greenhouses