Paper ID: 85889
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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NUTRITIONAL COUNTERMEASURES AGAINST IMMUNE SYSTEM DYSREGULATION CAUSED BY OXIDATIVE STRESS IN MICROGRAVITY AND IONIZING RADIATION IN LONG-TERM SPACEFLIGHTS

Abstract

In the space environment, astronauts are exposed to various forms of ionizing radiation, including energetic protons associated with potential Solar Particle Events (SPE) and Galactic Cosmic Rays (GCR). The potent ionization capacity of GCR ions makes them a significant concern for potential long-term physiological impacts. The Radiation Exposure Indicator Dose (REID) career limit for missions beyond Low Earth Orbit (LEO) is set at 3%. Currently, astronauts aboard the International Space Station (ISS) experience an average exposure of 1 mSv\day, which heightens the generation of reactive oxygen species (ROS), leading to oxidative stress (OS) due to an imbalance between free radicals and antioxidant defense. Space travel has been linked to dysregulation in both adaptive and innate immunity, with mitochondrial dysfunction serving as a key connection between oxidative stress and immune disruption. Mitochondrial dysfunction can trigger various stress signals, and both oxidative phosphorylation (OXPHOS) and ROS production are essential for T cell activation and when are activated these cells capable of utilizing OXPHOS for proliferation. One nutritional countermeasure against oxidative stress involves specific functional foods rich in anthocyanins, which act as free radical scavengers against harmful oxidants such as ROS and reactive nitrogen species (RNS). Additionally, vitamin C and Omega-3 fatty acids have shown promise in mitigating radiation-induced damage. Aim. Identify nutritional strategies to counteract immune system dysregulation caused by oxidative stress in microgravity and ionizing radiation during long-term spaceflights. Methods. To evaluating the effectiveness of antioxidants (anthocyanins, vitamin C, and Omega-3 fatty acids) in reducing oxidation products, primarily measured through lipid peroxidation assays in biological fluids, ((blood, serum, plasma, saliva, and urine) To assessing immune dysregulation by analysing leukocyte subset distribution via DNA methylation and intracellular cytokine profiles through flow cytometry after in vitro stimulation. Baseline assessments will be conducted pre-flight, with subsequent evaluations post-flight to assess the impact of nutritional supplementation on immune function and oxidative stress. This comprehensive approach aims to provide insights into effective nutritional interventions to mitigate the adverse effects of space travel on the immune system.