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Author: Mr. Attilio Marino
Italian Institute of Technology (IIT), Italy

Dr. Giada Graziana Genchi
Istituto Italiano di Tecnologia, Italy
Ms. Agostina Francesca Grillone
Istituto Italiano di Tecnologia, Italy
Ms. Ilaria Pezzini
Italy
Mr. Daniele de Pasquale
Istituto Italiano di Tecnologia, Italy
Prof. Alessandra Salvetti
Italy
Dr. Paola Iacopetti
Italy
Prof. Gianni Ciofani
Italy

CERIUM OXIDE NANOPARTICLES EXERT ANTIOXIDANT ACTIVITY PROTECTING DUGESIA JAPONICA PLANARIANS FROM HYPERGRAVITY-INDUCED OXIDATIVE STRESS

Abstract

Oxidative stress in living organisms is strictly related to an unbalance in production/removal of intracellular reactive oxygen species (ROS). Potentially harmful to many biomolecules, ROS are associated with a variety of pathological conditions, including cancer and neurodegenerative diseases. Living organisms are normally provided with endogenous defences (including superoxide dismutase –SOD- and catalase –CAT- enzymes) against ROS, but when these become insufficient a continuous antioxidant supply is required, as traditional antioxidants are chemically unstable and present short half-life in vivo. The use of nanomaterials with redox-reactive properties, such as cerium oxide nanoparticles (nanoceria), is therefore gaining increasing interest: nanoceria indeed show self-regenerating capability as free radical scavengers, and mimick both SOD and CAT activities. Performed in the framework of the 2016 "Spin Your Thesis!" campaign promoted by the European Space Agency, our work aimed at assessing the ability of nanoceria to protect a model organism, the planarian *Dugesia japonica*, from the oxidative stress induced by exposure to different hypergravity levels (10,20g).

Direct detection of the intracellular ROS levels was performed by using a ROS-sensitive fluorescent dye (DCFH-DA). Fluorescence imaging was performed at low magnification (5X), by keeping constant LED intensity, exposure time and gain for all experimental conditions. Enhanced fluorescence emission (average pixel intensity) was observed in planarians after exposure to 10g (10.8+-1.1 au) and 20g (23.66+-5.1 au) compared to 1g controls (7.8+-0.4 au; $p<0.05$), indicating hypergravity-induced ROS increment. NC-treated planarians that underwent hypergravity (8.0+-0.5 au for 10g+NC; 7.6+-0.5 au for 20g+NC) were characterized by fluorescence intensity similar to that of untreated 1g controls ($p>0.05$). This suggests that nanoceria treatment is able to counteract hypergravity-induced ROS increment, in agreement with preliminary experiments conducted in our laboratories, where planarians were exposed to 22g for 90 min.

No significant difference was detected between NC-treated and untreated planarians kept at 1g (7.2+-0.2 au), suggesting that NC did not perturb endogenous levels of ROS in planarians.

Concluding, our results demonstrate that planarians represent an in vivo model that can be successfully exploited for the investigation of ROS production in altered gravity conditions. An increase in hypergravity levels was demonstrated to be related to an increase of ROS amount in living planarians. Due to their biomimetic antioxidant activity, nanoceria were able to efficiently counteract hypergravity-mediated ROS increment in planarians. Future works will investigate biochemical pathways of ROS production during hypergravity treatments, and the effect of long-time hypergravity/nanoceria stimulation on ROS production and cell apoptosis.