View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Kazan Federal University Digital Repository

PLoS ONE, 2010, vol.5, N11

Anhydrobiosis-associated nuclear DNA damage and repair in the sleeping chironomid: Linkage with radioresistance

Gusev O., Nakahara Y., Vanyagina V., Malutina L., Cornette R., Sakashita T., Hamada N., Kikawada T., Kobayashi Y., Okuda T.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Anhydrobiotic chironomid larvae can withstand prolonged complete desiccation as well as other external stresses including ionizing radiation. To understand the cross-tolerance mechanism, we have analyzed the structural changes in the nuclear DNA using transmission electron microscopy and DNA comet assays in relation to anhydrobiosis and radiation. We found that dehydration causes alterations in chromatin structure and a severe fragmentation of nuclear DNA in the cells of the larvae despite successful anhydrobiosis. Furthermore, while the larvae had restored physiological activity within an hour following rehydration, nuclear DNA restoration typically took 72 to 96 h. The DNA fragmentation level and the recovery of DNA integrity in the rehydrated larvae after anhydrobiosis were similar to those of hydrated larvae irradiated with 70 Gy of high-linear energy transfer (LET) ions (4He). In contrast, low-LET radiation (gamma-rays) of the same dose caused less initial damage to the larvae, and DNA was completely repaired within within 24 h. The expression of genes encoding the DNA repair enzymes occurred upon entering anhydrobiosis and exposure to high- and low-LET radiations, indicative of DNA damage that includes double-strand breaks and their subsequent repair. The expression of antioxidant enzymes-coding genes was also elevated in the anhydrobiotic and the gamma-ray-irradiated larvae that probably functions to reduce the negative effect of reactive oxygen species upon exposure to these stresses. Indeed the mature antioxidant proteins accumulated in the dry larvae and the total activity of antioxidants increased by a 3-4 fold in association with anhydrobiosis. We conclude that one of the factors explaining the relationship between radioresistance and the ability to undergo anhydrobiosis in the sleeping chironomid could be an adaptation to desiccation-inflicted nuclear DNA damage. There were also similarities in the molecular response of the larvae to damage caused by desiccation and ionizing radiation. © 2010 Gusev et al.

http://dx.doi.org/10.1371/journal.pone.0014008