# Transcriptional changes induced by in vivo exposure to multi-walled carbon nanotubes (CNTs) in Chironomus riparius (Diptera) aquatic larvae

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The widespread use of carbon nanotubes (CNTs) in the industry and biomedicine provokes their dispersion in the aquatic environment through sources such as disposal of CNT-containing consumer products, waste discharges and accidental spills. CNTs are hydrophobic and nonbiodegradable in the nature, these materials can accumulate in sediments into aquatic environments. At present, the studies of the effects of CNTs on aquatic organisms are scarce. The main objectives of the present study were to investigate the toxicity of multi-walled carbon nanotubes (MWCNTs) and to evaluate the effects of carbon nanotubes at genomic level using Chironomus riparius, a reference organism in aquatic toxicology. We analyzed the impact of CNTs on the activity of several genes related with DNA repairing mechanisms, cell stress response, cytoskeleton, and cell apoptosis. The transcriptional activity of the ataxia-telangiectasia mutated (ATM), X-ray repair cross-complementing protein 1 (XRCC1), heat shock protein 27 (hsp27), heat shock protein 70 (hsp70), actin and caspase 3 genes were evaluated by real time RT-PCR in C. riparius larvae after 24 hours of exposure to MWCNTs. The obtained results in the present work show the activation of caspase delay gene and the downregulation of hsp27, hsp70, and ATM genes at the highest tested concentration of MWCNTs. Moreover, the transcriptional activity of XRCC1 gene, related with excision-repair mechanisms, was not modified after MWCNTs exposure. These effects could be reflecting the activation of apoptosis by MWCNTs in C. riparius. Moreover, these data reinforce the need of further studies for the environmental risk assessment of this nanomaterial.

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