Are bioplastics safe? Hazardous effects of polylactic acid (PLA) nanoplastics in *Drosophila*

M. Alaraby[1,2*], D. Abass[1,2], A. Hernández[1], & R. Marcos[1]

[1]Group of Mutagenesis, Department of Genetics and Microbiology, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain
[2]Zoology Department, Sohag University (82524), Sohag, Egypt
* mohamed.alaraby@uab.cat

Background: While the production of bioplastics increases continuously, there is a gap of information on the hazardous impact of their degradation products (micro/nanoplastics, MNPLs).

Aim: To understand the potential health risks associated with the exposure to MNPLs of bioplastics.

Methods: To address this issue, *Drosophila melanogaster* as a versatile terrestrial *in vivo* model was employed, and polylactic acid nanoplastics (PLA-NPLs), as a proxy for bioplastics, were tested as a material model. A wide battery of approaches has been applied in this study including internalization, gene expression, oxidative stress, and genotoxicity.

Results: The harmful effects were determined in larvae exposed for 4 days to different concentrations (25, 100, and 400 µg/mL) of 463.9 ± 129.4 nm PLA-NPLs. Transmission electron microscopy (TEM) and scanning electron microscope (SEM) approaches permitted the detection of PLA-NPLs in the midgut lumen of *Drosophila* larvae, interacting with symbiotic bacteria. Enzymatic vacuoles were observed as potential carriers, collecting PLA-NPLs and enabling the crossing of the peritrophic membrane, finally internalizing into enterocytes. Although no toxic effects were observed in the egg-to-adult survival, the cell uptake of PLA-NPLs causes cytological disturbances and the formation of large vacuoles. The translocation across the intestinal barrier was demonstrated by their presence in the hemolymph. Furthermore, PLA-NPL exposure triggered intestinal damage, oxidative stress, DNA damage, and inflammation responses, as evaluated via a wide set of marker genes. Collectively, these structural and molecular interferences caused by PLA-NPLs generated high levels of oxidative stress and DNA damage in the hemocytes of *Drosophila* larvae.

Conclusions: The observed effects point out the need for further studies aiming to deepen the health risks posed by bioplastics before considering their uses as a safe plastic alternative to the petroleum-based plastics.