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Biological effects of chronic oral exposure to polystyrene nanoparticles in Drosophila melanogaster

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One of the most significant environmental issues of our time is plastic pollution. Only a small part of plastic is recycled and, as result of chemical and physical processes, the plastic released into the environment breaks down into tiny particles that can cross biological tissue barriers. These fragments contaminate everything, from fresh and salty water to the food we consume and the air we breathe. Furthermore, due to the lipophilic nature of the nanoplastics, they accumulate in fatty tissues, biomagnifying the dose to which organisms are exposed. Given the high levels of exposure, it is crucial to assess the impact of nanoplastics on human metabolism and related health risks.

Drosophila melanogaster is a suitable animal model for toxicity and genotoxicity research. The aim of our study is to characterize the biological effects of oral exposure to polystyrene nanoparticles (PSNPs) on fruit flies. PSNPs are commonly used in food packaging and are one of the most widespread plastic pollutants. In order to characterise the PSNPs we used fluorescein-conjugated PSNPs and carried out a SEM analysis on the PSNPs themselves, the food additioned with PSNPs and the feces of wilde-type flies reared on the contaminated food. Fluorescence microscopy analysis revealed that PSNPs tend to accumulate in intestinal and fat body cells of flies fed with the additioned food, indicating that PSNPs cross the intestinal epithelium and are released into the circulatory flow.

Trypan blue staining on the intestine showed tissue damage following the ingestion of nanoparticles. Measurable physiological and behavioural endpoints (developmental timing, male fertility, adult body weight and larval crawling) were analyzed. In both pupal formation and adult hatching, a significant extension of development was observed along with a significantly reduced ability of adult flies to react to additional stress, such as starvation. Moreover, we tested the sensitivity of DNA damage repair (DDR) mutants to PSNPs as an indirect indication of genotoxicity. The analysis was conducted on the ligIV mutant, known to be hypersensitive to DNA damage induced by ionising radiation (IR) in early developmental stages and with a shortened lifespan under conditions of nutritional stress. Preliminary results suggest an effect on chromosome integrity and thus a genotoxic effect of PSNPs. We are currently focusing on this question to better define its health-related aspects.

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Drosophila, Genotoxicity; Nanotoxicology; Nanoplastics;