



MASTER THESIS PROJECT

IMPACTS OF BIODEGRADABLE MICRO AND NANO PLASTICS (BMNP) ON HUMAN HEALTH

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ABSTRACT

The development of biodegradable polymers has emerged as a promising approach for addressing the issues of conventional plastics. Poly Lactic Acid (PLA) is a commonly consumed biobased biodegradable polymer. Polycaprolactone (PCL) in contrast is a petroleum-based biodegradable polymer that is frequently used in tissue engineering techniques. Due to their high usage both of those polymers have accumulated in the environment in recent years. Current studies have revealed that biodegradable plastics require specific environmental conditions for breakdown including high temperature and moisture, which are not fulfilled in natural ecosystems. As a result of this, they accumulate in the environment owing to improper management. This leads to micro/nano plastics derived from biodegradable plastics accumulating in the natural environment in the same manner as conventional plastics. As they are persistent, they can be transported over a long range, and they can enter food webs and magnify in food chains. Humans are considered as vulnerable as they are easily exposed to these micro/nano plastics through food and drinking water. The oral route is the major route through which they enter the human body. To evaluate the risk of exposure to PLA and PCL nano plastics (less than 1 μm in size), an *in vitro* toxicity assay was carried out using three human cell lines Caco-2 (the site of entry), HeP G2, (site of detoxification), and SH-SY5Y, (central nervous system). The treated concentrations of PLA and PCL were 1,5,10,50,100,200,1000 $\mu\text{g/L}$, 10,50,10²,10³,10⁴,10⁵,10⁶ particles/mL respectively. High content analysis was performed to assess cytotoxic outcomes including cell number, nuclear area, nuclear intensity, mitochondrial mass, and mitochondrial membrane potential. The results revealed that cell number was depleted with Poly Lactic Acid in all three cell lines, with the greatest effect on SH-SY5Y cells. PCL showed a significant reduction in cell numbers only with SH-SY5Y cells. The mitochondrial mass of Caco-2 cells was severely impacted with PLA treatment. Mitochondrial membrane potential showed a significant increase in all three cell lines after exposure to PLA. To conclude, biodegradable plastics are potentially not as safe to human and environmental health as once considered although they emerged as nontoxic replacements to existing commodities.

Keywords

Biodegradable micro nano plastics, Caco-2, Hep G2, SH-SY5Y, cytotoxicity, cell number, mitochondrial membrane potential