



Comparative ecotoxicity of polystyrene nanoparticles in natural seawater and reconstituted seawater using the rotifer *Brachionus plicatilis*



L. Manfra^{a,b,*}, A. Rotini^c, E. Bergami^d, G. Grassi^d, C. Faleri^e, I. Corsi^d

^a Institute for Environmental Protection and Research (ISPRA) Rome, Italy

^b Department of Biology and Evolution of Marine Organisms, Stazione Zoologica Anton Dohrn Naples, Italy

^c Department of Biology, University Tor Vergata, Rome, Italy

^d Department of Physical, Earth and Environmental Sciences, University of Siena, Italy

^e Department of Life Sciences, University of Siena, Italy

ARTICLE INFO

Keywords:

Nanoplastics
Polystyrene
Rotifer
Ecotoxicity
PS NP surface charge
Suitable testing medium

ABSTRACT

The impact of nanoplastics using model polystyrene nanoparticles (PS NPs), anionic (PS-COOH) and cationic (PS-NH₂), has been investigated on the marine rotifer *Brachionus plicatilis*, a major component of marine zooplanktonic species. The role of different surface charges in affecting PS NP behaviour and toxicity has been considered in high ionic strength media. To this aim, the selected media were standardized reconstituted seawater (RSW) and natural sea water (NSW), the latter resembling more natural exposure scenarios. Hatched rotifer larvae were exposed for 24 h and 48 h to both PS NPs in the range of 0.5–50 µg/ml using PS NP suspensions made in RSW and NSW. No effects on lethality upon exposure to anionic NPs were observed despite a clear gut retention was evident in all exposed rotifers. On the contrary, cationic NPs caused lethality to rotifer larvae but LC₅₀ values resulted lower in rotifers exposed in RSW (LC₅₀ = 2.75 ± 0.67 µg/ml) compared to those exposed in NSW (LC₅₀ = 6.62 ± 0.87 µg/ml). PS NPs showed similar pattern of aggregation in both high ionic strength media (RSW and NSW) but while anionic NPs resulted in large microscale aggregates (Z-average 1109 ± 128 nm and 998 ± 67 nm respectively), cationic NP aggregates were still in nano-size forms (93.99 ± 11.22 nm and 108.3 ± 12.79 nm). Both PDI and Z-potential of PS NPs slightly differed in the two media suggesting a role of their different surface charges in affecting their behaviour and stability. Our findings confirm the role of surface charges in nanoplastic behaviour in salt water media and provide a first evidence of a different toxicity in rotifers using artificial media (RSW) compared to natural one (NSW). Such evidence poses the question on how to select the best medium in standardized ecotoxicity assays in order to properly assess their hazard to marine life in natural environmental scenarios.

1. Introduction

Plastic represents the prevalent marine litter (Barnes et al., 2009), with an estimated release of 8 millions tons per year and around 300,000 t expected to be in open-ocean surface waters including fragments of smaller sizes from microscopic to nanoscopic (Jambeck et al., 2015; Mattsson et al., 2015). Nanoplastic, referred as plastic particles in the < 100 nm size range, is probably the less known fraction of marine litter but potentially the most hazardous to marine life due to nanodimensional peculiar properties which make them largely different from the same polymer type in bulk form (Koelmans et al., 2015). Among plastic polymers found in marine litter, polystyrene (PS) has been reported to be the most abundant plastic type (OSPAR, 2015) and account for 6–7.8% of total plastic production worldwide with an annual

production of over 23 million tons per year (Lithner et al., 2011). As far as for most of the plastic polymers ending up into the environment as wastes, PS items are subjected to both abiotic and biotic weathering processes which lead to their degradation and fragmentation in smaller fragments of micrometric (microplastics, < 5 mm) and nanometric size (nanofragmentation, nanoparticles < 100 nm) (Shim et al., 2014). Therefore, PS nanofragments/particles will inevitably constitute a significant portion of floating plastic debris in ocean's surface waters. Polystyrene nanoparticles (PS NPs) are also directly discharged as wastes into the oceans being used for various applications such as biosensors, in photonics and self-assembling structures and even in consumer products and developed in research for medical applications as nanospheres and nanocapsules for drug delivery (Salvati et al., 2011; Loos et al., 2014).

* Corresponding author at: Institute for Environmental Protection and Research (ISPRA), Rome, Italy.

E-mail addresses: loredana.manfra@isprambiente.it (L. Manfra), alice.rotini@uniroma2.it (A. Rotini), bergami@student.unisi.it (E. Bergami), grassi@student.unisi.it (G. Grassi), faleric@unisi.it (C. Faleri), ilaria.corsi@unisi.it (I. Corsi).

<http://dx.doi.org/10.1016/j.ecoenv.2017.07.068>

Received 12 May 2017; Received in revised form 12 July 2017; Accepted 28 July 2017

Available online 08 August 2017

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