Biodegradable microplastics are less toxic than conventional ones to *Daphnia magna*

Zandra Gerdes[1], Mikaela Puranen, Martin Ogonowski[1,2], Elena Gorokhova[1]

1 Department of Environmental Science and Analytical Chemistry (ACES), Svante Arrhenius väg 8, 106 91 Stockholm, Sweden

2 Aquabiota Water Research AB (Aquabiota), Löjtnantsgatan 25, SE 115-50 Stockholm, Sweden

Production of biodegradable plastics is increasing but degradation of these polymers is slow in non-optimal environments. Faster degradation and fragmentation of bioplastics may therefore become a source of Microplastic particles, which is provoking the need for studies of their effects.

METHODS

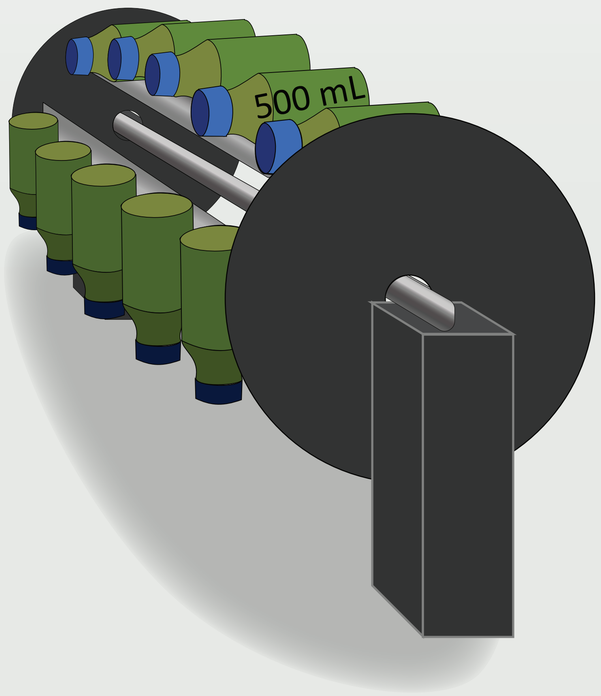
We conducted 3 experiments to evaluate effects by 3 materials: The plastics Polystyrene and PolyLactic Acid (PLA is biodegradable), and Kaolin a naturally occuring claymineral used as a reference particle.

1 *Daphnia magna* feeding test (72 h exposure):
- 6 ind. replicate^{-1} (<5 d old)
- 4 treatments – Control Algae, Control Kaolin, PS and PLA
- 3 Endpoints – Feeding rate, size and mortality

2 *D. magna* reproduction test (~19 d exposure):
- 1 ind. replicate^{-1} (<8 d old, from the feeding test)
- 4 treatments (same as **1**)
- 1 Endpoint – Population growth rate

3 *Nitocra spinipes* acute toxicity test (96 h):
- 10 ind. replicate^{-1}
- 2 Controls (+/- surfactant) and PS leachate

Experiments **1 & 2** were run on a plankton wheel



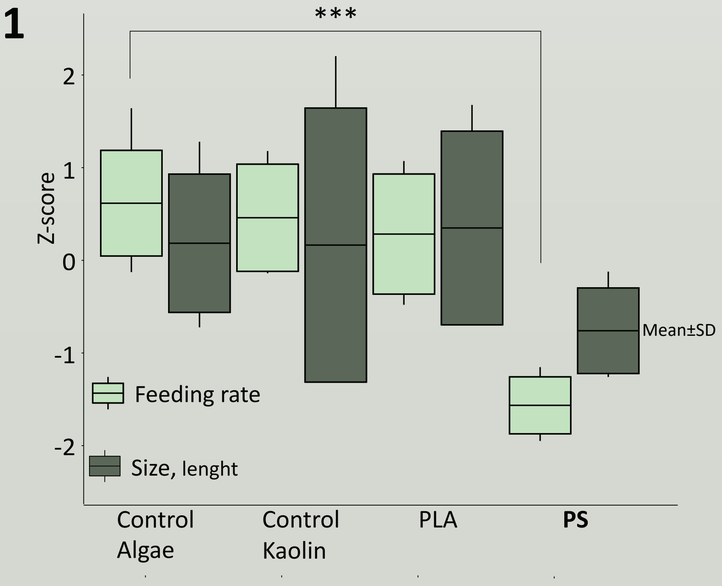
1 & 2 – Setup

Microparticles were prepared by sifting kryomilled material. Particle stocks were prepared in milliQ water with 0.01% Tween80 (surfactant).

Treatments	**PLA**	**PS**	**Control Kaolin**	**Control Algae**
Particle material	Poly-(Lactic Acid)	Poly-styrene	Kaolin clay	*Raphidocelis subcapitata*
Density g cm^3	1.3	1-1.1	2.6	
Mean size µm	3.4	5.1	1.6	
Exp. conc. # mL^{-1}	62400	62400	62400	
Exp. conc. µg mL^{-1}	19.6	39.7	0.58	
Algal food µg mL^{-1}	7.5	7.5	7.5	7.5
Algal food cells mL^{-1}	67900	67900	67900	67900
Replicates	6	6	6	8

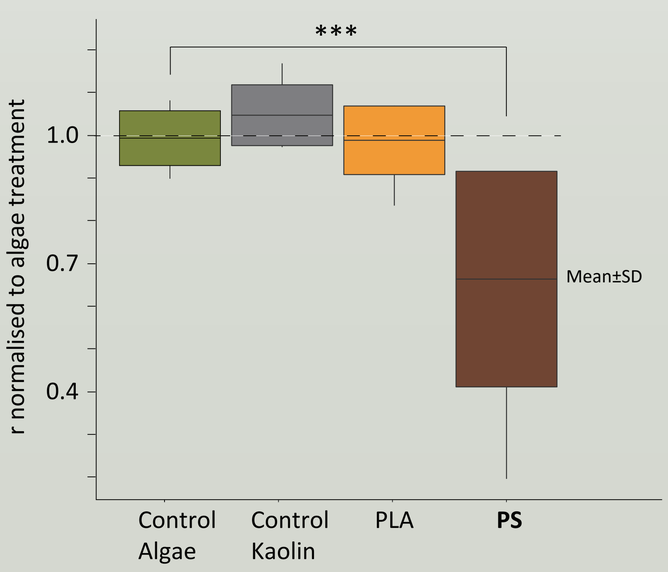
RESULTS

1



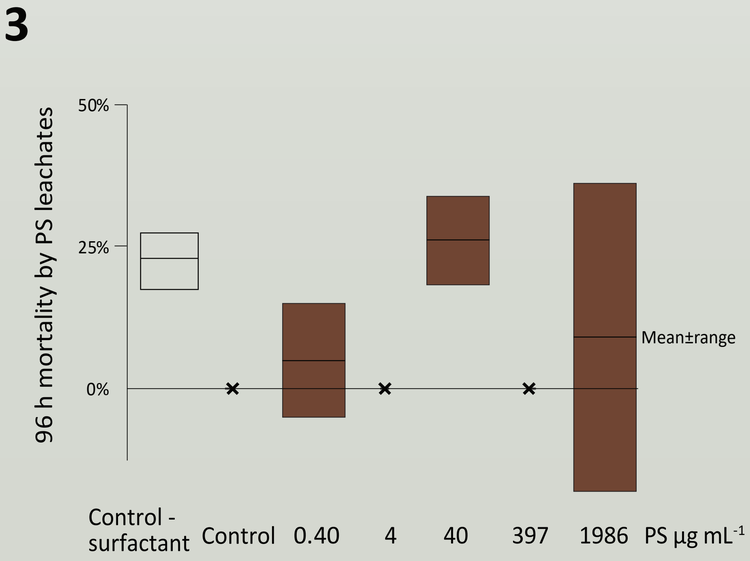
- PS exposure resulted in higher average mortality relative the other treatments, i.e. 17 % compared Controls: 0 % and PLA: 3 %.
- PS had a negative effect on feeding ($t_{3,22}$ = -7.4, p < 0.001, ***).
- PLA and Kaolin did not affect feeding or size.

2



- Population growth, the intrinsic rate of increase (r), was calculated per replicate with the Euler–Lotka equation. PS had a negative effect compared Control Algae ($t_{3,21}$ = -4.3, p <0.001, ***).
- No effects were observed by PLA or Kaolin.

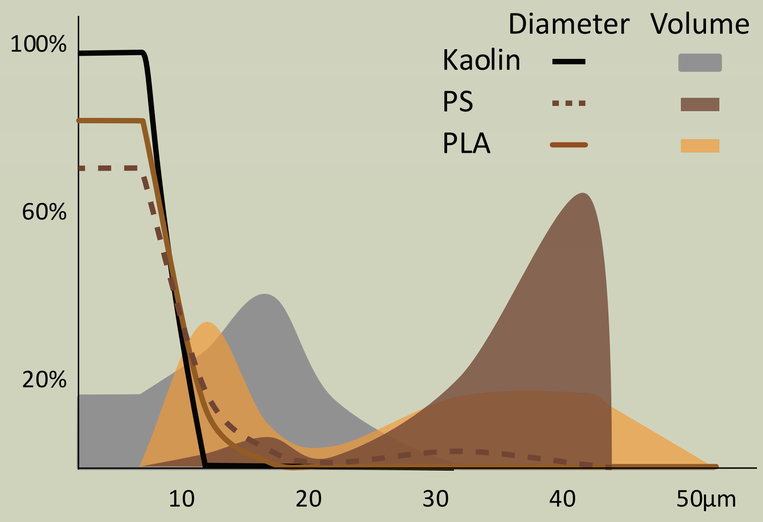
3



- No dose response toxicity by PS leachates
- Large response variability in the highhest leachate dose
- High mortality in the surfactant control - possibly due to test media dilution

CONCLUSIONS

Size distributions of test particles



PLA had no effect on any of the investigated endpoints at this high particle test concentration.

PS exposure decreased *D. magna* feeding rate, which resulted in a **decreased reproductive growth**.

The majority of particles were <10µm, for all materials, still the particle sizes' contribution to total volume differs much for PS compared to PLA and Kaolin.

– A small difference in size distribution may cause large effects, as for PS. Whether the specific size was responsible for the observed toxicty remains uncertain.

Food dilution is recognized as one cause for negative effects by MP ingestion. It may depend on both number of ingested inert particles and their volume in the gut.

Are equal particle concentrations and continous resuspension enough for comparable exposures?

Acknowledgement

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