

Science for Environment Policy

Polystyrene nanoparticles affect fish behaviour and metabolism

Fish fed polystyrene nanoparticles are less active and show changes to their brains and metabolism, according to a study by Swedish and Danish researchers. The findings suggest that nanoparticles in the environment could have a major impact on fish and aquatic ecosystems.

Nanoparticles are increasingly used in consumer products, such as cosmetics, and enter the environment via sewage systems. Plastic [waste](#), found throughout the world's oceans, also disintegrates over time, producing plastic nano-sized particles. Nanoparticles in industrial and consumer products are controlled by existing regulations such as the [REACH](#) or [cosmetics Regulations](#)¹; the underlying assessments are complex as many substances behave differently at the nano-scale. The effect of nanoparticle exposure on people and animals is not fully understood, although there is evidence that some may be harmful, particularly to fish.

As a result, researchers need to establish how nanoparticles affect fish and other aquatic organisms to prevent the degradation or loss of aquatic 'ecosystem services', such as the supply of fish for food, as well as to minimise human exposure to those that are hazardous. A better understanding of nanoparticle behaviour will enable policymakers to develop appropriate regulations for their safe use and disposal.

To investigate the effects of nanoparticles on fish, the researchers introduced nanoparticles into the diet of the Crucian carp (*Carassius carassius*) in laboratory tests which recreated a simple food chain.

The particles were made of polystyrene and around 24–27 nanometres (nm) in size. The researchers began by introducing the particles to green algae at a concentration of 9.3 trillion particles per ml, which were eaten by water fleas (*Daphnia magna*). These in turn were fed to a group of carp once every three days, and the fish consumed around 130 mg of nanoparticles per feed. A separate group of carp received the same diet but without the nanoparticles.

The behaviour of both groups of fish while feeding was filmed on this first day, and after 25 and 62 days of the experiment. At the end of the experiment, the carps' organs were weighed and measured and the researchers used a technique called nuclear magnetic resonance (NMR) to examine differences in metabolism between the two groups.

The behavioural recordings showed that nanoparticle-fed fish fed for twice as long, moved more slowly, and were less active after feeding. They also swam closer together.

The NMR results showed clear differences between the two groups of fish in their livers and muscles. These changes consisted of a series of small changes to many different molecules produced by metabolic reactions ('metabolites'), rather than one or two major differences.

Physically, the brains and muscles differed between the two groups, with nanoparticle-fed fish showing heavier, swollen-looking brains that were whiter and fluffy in texture, due to increased water content.

The results suggest that polystyrene nanoparticles have wide-ranging effects on fish behaviour, metabolism and physiology. Fish that fed on food contaminated with nanoparticles appeared to have less energy, possibly because their energy reserves were depleted or inaccessible due to metabolic changes. Slower, less active feeding is likely to lead to smaller fish, which could affect fish harvests and other ecosystem services.

Previous work has shown that polystyrene molecules interact with fats, including those in cell membranes. However, the researchers caution that further research is needed to understand how these nanoparticles affect metabolism and brain structure and how these link to the observed behavioural changes.



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1.Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:136:0003:0280:EN:PDF>
Regulation (EC) No 1223/2009 on cosmetics products. <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L1223&from=EN>