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Colourful plastics may lead to more microplastics – study finds

Canisters and bottles collected for the study at a remote stretch of beach in De Hoop Nature Reserve.

Photo: Peter Ryan

Plastics with bright colours such as red, blue and green degrade to form microplastics quicker than those with plainer colours, researchers from the University of Cape Town (UCT) and the University of Leicester have demonstrated.

The findings reveal that the colourants used in the formulation of a plastic product can significantly affect the rate at which it degrades and break down, potentially introducing harmful plastics into the environment more quickly.

Published in the journal *Environmental Pollution*, it is the first time this effect has been proven in a field study and could be important for retailers to take into account when designing plastics and packaging.

Plastics mostly break down when ultraviolet (UV) radiation changes the plastic's polymer structure, making it brittle and susceptible to fragmentation. The researchers used two complementary studies to show that items made from high density polyethylene degrade at different rates depending on what is added to colour them.

One study exposed bottle lids to the elements on the roof of a building at the University of Leicester for three years. The second study collected plastic samples from canisters and bottles of known age that were washed ashore on a remote beach in De Hoop Nature Reserve, South Africa. The dates of manufacture were known from date stamps embossed into the plastic items.

The scientists measured how chemically degraded the samples were as well as their structural integrity. Both studies showed that black, white and silver colourants protect plastic from damaging UV radiation whereas other pigments do not. The blue, green and red lids became brittle and broke up into microplastics within three years even when exposed to the notoriously un-sunny British weather. Samples from South Africa were up to 45 years old, but all older items were plain colours.

Peter Ryan, an Emeritus Professor at the FitzPatrick Institute of African Ornithology at UCT and co-author of the study, contributed to the paper by providing known-age plastic samples from De Hoop beach.

"The combination of short-term degradation experiments and the longer-term beach litter samples clearly indicate that bottles with different colorants break down at different rates. From an environmental perspective, we'd prefer littered bottles to remain intact as long as possible so they can be removed from the environment and recycled or disposed of responsibly – by being incinerated for energy production, turned into fuels by pyrolysis or, in the worst case, buried in landfills. Once they break down into microplastics, it is much harder to deal with environmental plastics," said Professor Ryan.

The research was led by Dr Sarah Key, who conducted the studies while a PhD student at the University of Leicester School of Chemistry and funded by CENTA – The Central England NERC Training Alliance, and is now a senior research analyst with climate action NGO WRAP (Waste & Resources Action Programme).

Dr Key said: "It's amazing that samples left to weather on a rooftop in Leicester in the UK and those collected on a windswept beach at the southern tip of the African continent show similar results.

"What the experiments showed is that even in a relatively cool and cloudy environment for only three years, huge differences can be seen in the formation of microplastics. Colourful plastics, such as red and green, degrade and form microplastics pretty quickly. When you look at more plain colours, such as black and white, they're actually quite stable and remain intact.

"Next time you clean up some plastic litter, take note of the colour and think about how soon it would have otherwise broken down. Whatever the colour, always check the packaging for details of how to recycle plastic packaging."

Microplastics display different properties from their original bulk materials, and little is understood about their impact on the environment. It is known that they can release toxic

plastic additives into the environment and they can potentially be transferred to humans, as well as toxic chemicals on their surfaces, through the food chain and water supplies.

The study has significant implications for material design, and suggests that manufacturers should give more consideration to the colour of short-lived plastics.

Dr Key added: "Manufacturers should consider both the recyclability of the material and the likelihood of it being littered when designing plastic items and packaging. For items that are used outdoors or extensively exposed to sunlight, such as plastic outdoor furniture, consider avoiding colours like red, green and blue to make them last as long as possible. Where the plastic is designed to break down, such as by using pro-oxidant additives, consider the role that colour could play in this."

Co-author Professor Sarah Gabbott, from the University of Leicester School of Geography Geology and the Environment, said: "I've often wondered why microplastics in beach sand often appear to be all the colours of the rainbow. Until our study I assumed that my eyes were being deceived and that I was just seeing the more colourful microplastics because they were easier to spot. Turns out there really are likely to be more brightly-coloured microplastics in the environment because those plastic items pigmented red, green and blue are more susceptible to being fragmented into millions of tiny, yet colourful microplastic particles."

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