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ADSORPTION PROPERTIES OF HEAVY METALS ON FIVE DIFFERENT MICROPLASTICS

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PURPOSE OF THE ABSTRACT

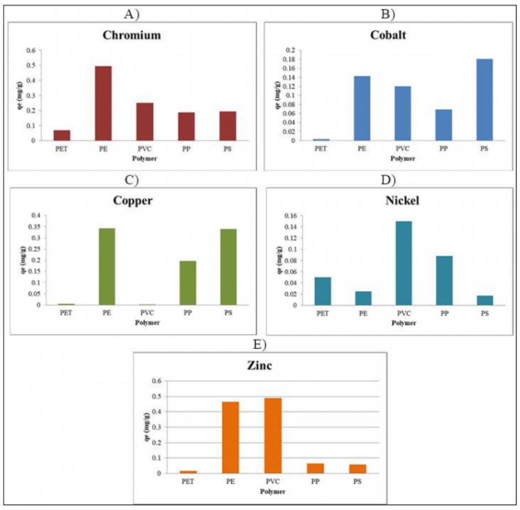
The annual global amount of discarded plastics has been reported to exceed 320?million?tonnes currently (Wright and Kelly, 2017), 10% of which eventually reach and persist in the aquatic environment (Jambeck et al., 2015). Polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), polystyrene (PS) and polyvinyl chloride (PVC) plastics are easily decomposed to microplastics in an aquatic environment. Currently, microplastics have become an emerging global concern, not only because of their hazards but also because of their interactions with other pollutants (Galloway and Lewis, 2016). For example, some heavy metals might be released and adsorbed by the polymer microplastics causing additional pollution to the ecosystem.

The adsorption of some heavy metals onto a range of natural materials has been well quantified, but not for the microplastics, whose interest has been growing more in recent years. In the present work, the adsorption capacity of microplastics composed of PE, PET, PP, PS and PVC on five heavy metals has been studied: chromium, cobalt, copper, nickel and zinc. Dissolutions of 100 mL of each metal with a concentration of 1 mg?L-1 were used, to which 0.1 g of microplastics were added. They were kept stirring at 160 rpm for 7 days, and the adsorption behavior was studied at different contact times (between 24-144 hours). Figure 1 shows the adsorption capacities of the polymers for chromium (Figure 1A), cobalt (Figure 1B), copper (Figure 1C), nickel (Figure 1D) and zinc (Figure 1E) on the last day of the experimental test (after 144 h of contact). Chromium, copper and zinc are, in general, the metals that are best adsorbed. In the case of cobalt and nickel, the adsorption capacity is very low in all polymers, just reaching 0.2 mg/g. With regard to polymers, PE is the one with the best adsorption capacity, while PET does not adsorb practically any of the metals proposed.

Regarding the contact time, Figure 2 shows the adsorption capacities of the polymers and metals that worked best, in function of time (from 24 to 144 hours). Only polymers and heavy metals that presented an adsorption capacity close to or greater than 0.2 mg/g were reported. In view of the results, it can be inferred that, for all polymers, chromium and zinc present a high adsorption in the first 48 hours of contact, while copper and cobalt increase more slowly and progressively over the days. Table 1. Adsorption capacities of the most related polymers and metals measured every 24 hours, over 144 hours (seven days).

The results of this work allow us to conclude that the microplastics present in the environment, especially PE and PVC, are capable of adsorbing heavy metals present in the medium and carrying them along the trophic chain.

FIGURES



Polymer	Heavy metal	Time (h)					
		24	48	72	96	120	144
PE	Chromium	0.036	0.329	0.419	0.495	0.488	0.494
	Copper	0.048	0.068	0.045	0.195	0.261	0.342
	Zinc	0.216	0.256	0.278	0.310	0.414	0.466
PS	Chromium	0.207	0.232	0.184	0.208	0.234	0.194
	Copper	0.192	0.198	0.200	0.244	0.265	0.340
	Cobalt	0.078	0.092	0.095	0.183	0.220	0.181
PP	Chromium	0.064	0.141	0.135	0.135	0.179	0.188
	Copper	0.093	0.127	0.178	0.173	0.164	0.196
PVC	Chromium	0.170	0.180	0.230	0.220	0.230	0.250
	Zinc	0.320	0.330	0.340	0.400	0.450	0.490

FIGURE 1

Capacity of adsorption (qe) of diverse heavy metals on five microplastics, after 144 hours of contact: A) Chromium; B) Cobalt; C) Copper; D) Nickel; E) Zinc.

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FIGURE 2

Adsorption capacities of the most related polymers and metals measured every 24 hours, over 144 hours (seven days).

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KEYWORDS

Adsorption | Environmental pollution | Heavy metals | Microplastics

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