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Biodegradability of single-use polypropylene-based face masks, littered during the COVID-19 pandemic – a first approach

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The COVID-19 pandemic caused a massive use of disposable sanitary face masks. Based on data provided by Prata et al. (2020), we estimated that if only 0.1% of those masks are improperly discarded and enter the soil, approximately 361t of polypropylene (PP) will be monthly added to the soil, threatening the ecological balance of terrestrial systems, the health of wild animals and even humans. For a first evaluation of the environmental consequences of the mask littering during COVID-19, we compared the microbial degradability of 10 x 10 mm cuts of the single masks layers and the complete mask blended with topsoil from a Cambisol of the Sierra de Aznalcóllar, Southern Spain with natural soil organic matter (SOM) by measuring the CO_2 release during a three-month decomposition experiment performed with a soil moisture of 75% of its maximal water holding capacity and at 25°C. In order to focus on biodegradation and to avoid abiotic impact of physical and chemical processes, the masks were not pretreated or exposed to UV-irradiation or natural daylight prior to decomposition. In addition, the incubation occurred in the dark. We identified an easily decomposable fraction with a mean residence time (MRT_{fast}) of 2 to 3 days, releasing approximately 3 to 5% of the total mask carbon as CO_2. Solid-state nuclear magnetic resonance (NMR) spectroscopy confirmed that all three layers of the mask were composed of PP without contributions of more than 2-3% of other additives. Microbial degradation resulted in a cut-off of terminal PP units as a main degradation mechanism. Assuming again that about 0.1% of the masks used during the COVID-19 crises may enter soil systems, we estimated that this fast pool may cause an additional CO_2 emission of 41 to 68 t $year^{-1}$. This corresponds to the globally averaged annual CO_2-footprint of 10 to 17 persons (4 t $year^{-1}$ $person^{-1}$). The slow turning fraction was mineralized with a rate constant of 0.05 to 0.14 $year^{-1}$ corresponding to a MRT_{slow} between 7 and 18 years. This is two to four times longer than that determined for the SOM pure reference soil but still lies in the range reported for humified SOM derived from other topsoils of the Sierra de Aznalcóllar. Our results allow us to confirm our hypothesis that in soil, microbes exist that can decompose PP, although their nature still has to be revealed in future attempts. Studies investigating the impact of pre-exposure to daylight and moisture on their degradability in soils are in process.

Prata, J.C., Silva, A.L.P., Walker, T.R., Duarte, A.C., Rocha-Santos, T., 2020. COVID-19 Pandemic Repercussions on the Use and Management of Plastics. Environ. Sci. Technol. 54, 7760–7765. https://doi.org/10.1021/acs.est.0c02178