Toward a better knowledge of domestic sewage fluorescent dissolved organic matter: a study of its biological and physicochemical properties

Goffin A[1,2], Guérin S[2], Rocher V[2], Varrault G[1]
[1]LEESU, Université Paris-Est (UMR MA 102), UPEC, Ecole des Ponts ParisTech, AgroParisTech, France, 61 avenue du Général de Gaulle, 94000 Créteil
[2]SIAAP, Direction Innovation Environnement, France, 82 avenue Kléber, 92700 Colombes

Dissolved organic matter (DOM) fluorescence from domestic sewage is most often dominated by the presence of protein-like components with a lowest part of humic substances-like components (Goffin et al., 2018). Particular attention was paid on domestic sewage humic substances-like fluorescent components, which are poorly known, especially since synthetic organic molecules (e.g. optical brightening agents, OBAs) are likely to fluoresce in the same excitation-emission wavelength areas of the fluorescence spectrum. This study (MOCOPEE research program) aims to use physicochemical and biological fractionation methods coupled with excitation-emission matrix (EEM) fluorescence spectroscopy to better understand the origin of humic substances-like fluorescence signature observed in domestic sewage.

Different nature of filtrated samples (0.45 µm; GF/F filters) were investigated: domestic sewage samples from the "Seine Centre" wastewater treatment plant (240,000 m^3/day; Colombes, France); samples from French Rivers under low urban pressure; Suwannee River fulvic acid standard (IHSS) and laundry detergent solutions with or without OBAs. All samples were fractionated on DAX-8/XAD-4/AGMP-50/AGMP-1 resins in duplicates following protocol used by Matar (2012). Dissolved organic carbon (DOC) measurements were made for each resin effluents and analysed at pH 8 with EEM fluorescence spectroscopy. Biodegradability experiments were also made on the previous filtered samples (0.45 µm; GF/F filters) using an Oxitop® respirometer under dark condition for 15 days. EEM fluorescence spectroscopy and DOC measurements were made at 0 and 15 days of experimentations, in triplicates.

Humic substances are known to be retained on DAX-8 resin (Peuravuori et al., 2002) and to be relatively refractory to biodegradation compared to protein. Domestic sewage biodegradation experiments highlighted a high biodegradability of protein-like fluorescent components (-90% of fluorescence intensity) and an increase of humic substances-like fluorescent components (+28% of fluorescence intensity) observed between 0 and 15 incubation days. Fractionation by DAX-8 resins showed only half of the domestic sewage humic substances-like fluorescence (55%) was observed in the hydrophobic acid fraction. All these observations raised doubts about the attribution of humic substances-like fluorescence signal to real humic substances in domestic sewage. According to a mass balance calculation it can be possible that OBAs are emitted in sufficient quantities to cause about 10% of the fluorescence observed for humic substances-like components in domestic sewage.

This study showed that EEM fluorescence spectrometry coupled with biological or physicochemical fractionation steps makes possible to distinguish fluorophores in domestic sewage according to their biodegradability and physicochemical properties. Results obtained also provide a better understanding of domestic sewage fluorescent DOM properties. This could help to better understand their possible evolution during the wastewater treatment plant process but also to consider a better management of the wastewater treatment works based on these elements.

Keywords: Humic substances; sewage dissolved organic matter; fluorescence spectroscopy; biodegradation; physicochemical fractionation.

References

Goffin A., Guérin S., Rocher V. & Varrault G., 2018. Towards a better control of the wastewater treatment process: Excitation-emission matrix fluorescence spectroscopy of dissolved organic matter as a predictive tool of soluble BOD_5 in six Parisian wastewater treatment plant influent samples. *Environ Sci Pollut Res* 25, 8765–8776.

Matar Z., 2012. Influence de la matière organique dissoute d'origine urbaine sur la spéciation et la biodisponibilité des métaux dans les milieux récepteurs anthropisés. PhD. Thesis, University of Paris-Est. 259 p.

Peuravuori J., Koivikko R. & Pihlaja K., 2002. Characterization, differentiation and classification of aquatic humic matter separated with different sorbents: synchronous scanning fluorescence spectroscopy. Water Research 36, 4552–4562.