**Evidence for the impact of sulfamethoxazole residues on denitrification rates in soil and formation of transformation products of concern.**

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There is an increasing interest in reusing treated wastewater for irrigation in water-stressed countries. Wastewater reuse is currently of particular concern as potential source of antibiotics residues and of antibiotic resistance spreading in soil. Less is known about consequences of the occurrence of antibiotics residues on soil quality. The antibacterial properties of antibiotics may influence denitrifying bacteria and denitrification rates. The significance of this issue remains unclear in soil because studies have been limited to aquatic ecosystems. In this latter environment, the occurrence of antibiotics has been recently associated with the inhibition of the growth of denitrifying bacteria leading to the accumulation of more reactive nitrogen and with an increase in nitrous oxide (N2O) release (HOU 2015).

Soil slurry incubation experiments upon denitrification conditions and in presence of high amounts of nitrate and easily biodegradable organic carbon were conducted to determine the influence of sulfamethoxazole (SMX, a sulphonamide antibiotic) on denitrification kinetics and the related nitric oxide (NO) and nitrite ions (NO2-) formation. SMX was observed to significantly inhibit denitrification rates at environmental concentrations (1 µg/L) but increasing SMX concentrations (10 µg/L) also enhanced the accumulation rates of NO and NO2-. The formation of 4-nitro-SMX, a transformation product which still exhibits clear antibacterial effects (MAJEWSKY 2014) together with the formation of 4-nitroso-SMX, a transformation product with suspected genotoxicity, were also observed. A mechanism for the formation of 4-nitro-SMX in anoxic sediment/water system has been previously reported3. However, further discussions of mechanistic issues will be presented. This study demonstrated that the nitration reaction was probably due to peroxynitrite (ONOO-), a well known nitrating agent, which results from the reaction of NO with superoxide anion radical (O2.-). The detection of the nitroso derivative of SMX might be due in part to the back-transformation of 4-nitro-SMX to SMX under reducing conditions but another still not fully elucidated transformation pathway is also probably involved.

All these results imply that the wide occurrence of antibiotics residues in treated domestic wastewater used for crop irrigation may disturb the nitrogen-cycling processes in soil mainly by inhibiting denitrification and probably stimulating the formation of toxic nitroso and nitro derivatives. This has been evidenced for SMX but might also affect others contaminants of emerging concern such as diclofenac.

References

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