Behaviour of three pharmaceuticals in soil applied by urine fertilisation

Martina Winker*, Joachim Clemens, Margrit Reich*, Holger Gulyas*, Ralf Otterpohl***

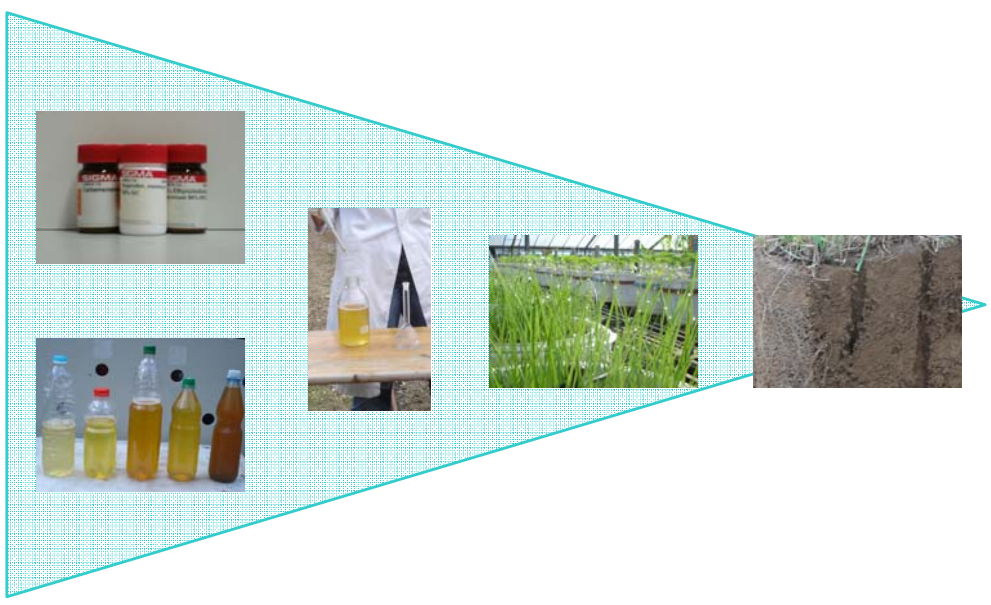
***Hamburg University of Technology, ** University of Bonn**

INTRODUCTION

Urine is a valuable plant fertiliser. But aside of high loads of N, P, and K, it also contains pharmaceutical residues. In the case of its application as fertilizer, knowledge is required for the expected behaviour of pharmaceuticals in soil. If active agents are very mobile, they might have the potential for groundwater contamination. This was investigated within a greenhouse pot experiment. Rye grass was planted in luvisol fertilized with pharmaceutical-spiked urine.

MATERIAL & METHODS

Urine was spiked with carbamazepine (CZ), ibuprofen (IBU), and 17α-ethinylestradiol (EE2) in concentrations expected in an average German urine (AGU; Winker et al., 2008) as well as CZ and IBU in its 10 fold conc. and EE2 in its 40 fold conc. Pharmaceuticals were added alone as well as in combinations. The growth period lasted for three months.



Soil samples were taken at the end of the experiment by a soil corer, dried and ground. After they were shaken in methanol and filtered methanol extracts were silylated. The solutions were analysed in duplicate by GC/MS.

Table shows recovery rates, limit of detection and quantification of the three investigated pharmaceuticals in soil.

Pharmaceutical	Recovery rate (%)	LOD (µg kg^{-1})	LOQ (µg kg^{-1})
CZ	90 – 120	0.2	0.6
IBU	30 – 60	1	2
EE2	50 – 60	1	2

RESULTS AND DISCUSSION

After three months growth period, only CZ could be detected in soil by GC/MS analysis. Concentrations found in soil samples correlated clearly with the applied CZ concentration of 3.2 µg kg^{-1} DM (conc. in AGU: n) and 32 µg kg^{-1} DM (10 x conc. in AGU: a) according to one-way ANOVA ($P < 0.05$). An average of 49 % of the applied CZ was recovered in soil regardless if added to pots alone or in combination with IBU and/or EE2.

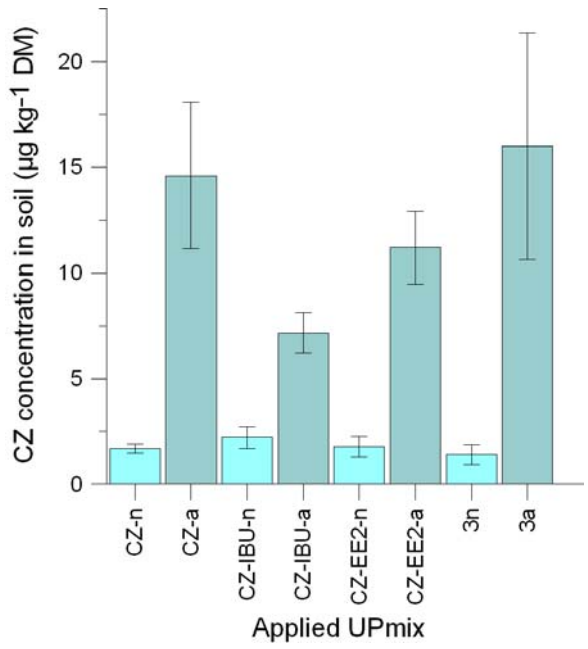


Figure shows measured mean concentrations of carbamazepine in soil samples. Error bars show standard deviation of the three pots.

Lacking detection of EE2 was expected as applied concentrations were rather low (highest dose: 0.1 µg kg^{-1} DM; 40 x conc. in AGU) and EE2 is additionally well biodegradable. Lacking detection of IBU could not be explained by LOD (1 µg kg^{-1} DM). As it is known to be biodegradable it can be assumed that even the artificial dosing (940 µg kg^{-1} DM soil; 10 x conc. in AGU) was degraded to below LOD.

CONCLUSION & OUTLOOK

It can be concluded that the biodegradation potential is a good indicator to determine causes and effects of pharmaceuticals for agricultural fields in case of urine application. Focus for future research should lay on highly persistent pharmaceuticals as they have the potential to accumulate over longer time spans and to reach deeper soil layers, maybe even groundwater.

ACKNOWLEDGEMENT

The authors thank the Deutsche Bundesstiftung Umwelt to award a scholarship to Martina Winker, M.Sc. The research was accomplished in the 6th EU framework project ‘SWITCH’.

REFERENCES

Winker, M., Tettenborn, F., Faika, D., Gulyas, H., and Otterpohl, R., 2008. Comparison of analytical and theoretical pharmaceutical concentrations in human urine in Germany. *Water Research* 42 (14), pp. 3633 – 3640.

Contact:
Martina Winker

Institute of Wastewater Management and Water Protection
Hamburg University of Technology, Germany
www.tuhh.de/aww

Tel.: +49 40 42878 2982
Fax: +49 40 42878 2684
m. winker@tuhh.de