Supplementary Information

Struvite: towards a circular phosphorus economy

Comment on Chen et al. Application of Struvite Alters the Antibiotic Resistome in Soil, Rhizosphere, and Phyllosphere.

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Analysis of pharmaceuticals in different influents

Both municipal and swine wastewater contain significant amounts of antibiotics. The concentration of most of the selected antibiotics are on average significantly higher in swine wastewater than in communal wastewater, especially the concentrations of doxycycline and sulfamethazine (see Table S1). The concentration is dependent on the amount of antibiotics in the feed addition of the swines. Antibiotics are poorly taken up by pigs, which results that 70-90% of the used antibiotics end up in the wastewater in unchanged form or as metabolites.[1] The amounts of antibiotics analysed in swine wastewater differ among the sampling locations and depends on the antibiotic intake of the pigs.

Table S1. Concentrations of selected antibiotics in communal wastewater influent in WWTPs in municipal wastewater and in swine wastewater influent samples from multiple locations.

Compound	**Municipal wastewater influent µg/L**	**Swine wastewater influent µg/L** [1]
Tetracycline (TC)	Wisconsin, U.S., 48[2] Sweden, 0.16[3] Singapore, 50[4] Hunan Province, Southern China, ND[5] Mexico, <0.01–0.1[6]	Jiangsu, China, ND–84.30 Beijing, China, 126.0–388.70 South China, 1.45–10.59
Oxytetracycline (OTC)	Wisconsin, U.S., 47[2] Singapore, 75[4] Hunan Province, Southern China, 50[5] Mexico, 0.04–0.13[6]	Beijing, China, 6.18–25.36 South China, 18.70 Shandong, China, 8.05 East China, 23.80 Taiwan, ND–5.33
Chlortetracycline (CTC)	Wisconsin, U.S., 0.31[2] Singapore, 7.5[4] Hunan Province, Southern China, ND[5]	East China, 13.70 Shandong, China, 8.05 Beijing, China, 2.65–32.67 Germany, 4.10 Taiwan, ND–4.32
Doxycycline (DC)	Wisconsin, U.S., 10[2] Hunan Province, Southern China, ND[5]	East China, 685.60
Sulfadiazine (SDZ)	Wisconsin, U.S., NA[2] Hunan Province, Southern China, 39[5] Mexico, 0.22–1.2[6]	East China, 98.90
Sulfamethazine (SMZ)	Wisconsin, U.S., 0.30[2] Singapore, 0.3[4] Hunan Province, Southern China, 22[5]	Beijing, China, 0.44–324.40 Jiangsu, China, ND–63.60 Shandong, China, 14.56 Bayer, Germany, 18.50–19.20 Germany, 49.50
Ciprofloxacin (CIP)	Wisconsin, U.S., 0.31[2] Sweden, 0.39[3] Singapore, 5.0[4]	0.01[7]

	Hunan Province, Southern China, ND[5] Mexico, 0.48–1.9[6]	
Enrofloxacin (ENR)	Wisconsin, U.S., 0.25[2] Hunan Province, Southern China, ND[5]	0.01[7]

NA. Not analysed; ND. Not detected.

Analysis of pharmaceuticals in struvite

We have compared the amounts of antibiotics in the struvite used in the research of Chen et al.[4] with struvite produced from swine wastewater described in the research of Ye et al.[5] and struvite produced at a WWTP from sludge water of a municipal wastewater.[6] The comparison in Table S2 clearly illustrates the differences in magnitude concerning the amount of antibiotics present in the three types of struvite. The struvite analyzed by Chen et al. contains significantly higher levels of all the analysed antibiotics. Especially the difference between the analysis of the struvite of Chen et al. and Ye et al., both from swine wastewater, is an interesting observation. The difference is almost for all antibiotics more than 100 fold higher in the struvite of Chen et al. Chen et al. do not mention in their paper how they produced the used struvite.

In the analysis of antibiotics in struvite from the aqueous phase of municipal wastewater only cyprofloxacin was detected just above the detection limit, 0.009 mg/kg, 567 times lower than the amount found in the struvite used by Chen et al., see Table 2. The difference in quality is even more apparent in the case of doxycycline: struvite used by Chen et al. contains 742 mg/kg, whereas the amount of doxycycline in the struvite produced from municipal wastewater was found to be below the detection limit (<0.005 mg/kg), therefore at least 148,000 times lower. The only micro-pollutants above the detection limit in the analysis of the struvite from the aqueous phase are Triclosan (0.013 mg/kg), Caffeine (0.014 mg/kg), Carvedilol (0.007 mg/kg) and Carbamazepine (0.006 mg/kg).

Table S2. Comparison of different types of struvite and the UBM Norm.

	Struvite Chen et al. from swine wastewater (mg/kg)[8]	Struvite Ye et al. from swine wastewater by using a fluidized bed (mg/kg)[9]	Airprex struvite from municipal wastewater (mg/kg)[a]	Crystal Green struvite from municipal wastewater (mg/kg)[b]	Struvite from municipal wastewater in Amsterdam West[10]	Struvite from municipal wastewater in Echten[10]	Struvite from municipal wastewater in Leuven[10]	Struvite from municipal wastewater in Land van Cuijk[10]	Theoretical struvite	Norm UBM
Total Carbon	35.39		1.63%						0	
Total Nitrogen	43.28		5.99%		21.2	30.0	20.0	55.4	57.1	
Cr	10.01		8		10.64	16.02	5.74	5.0	0	1875
Cu	71.55		48		20.62	7.01	4.02	<2.12	0	1875
Pb	1.47		11		17.96	2.32	1.43	<1	0	2500
Zn	521.50		90		71.85	21.05	23.52	3.0	0	7500
Tetracycline	415.21	0.3-2	<0.005	<0.01						
Oxytetracycline	360.1	0.5-2	<0.005	<0.01						
Chlorotetracycline	420.32	0.2-0.7	-	<0.01						
Doxycycline	742.07	0.3-1.9	<0.005	<0.01						
Sulfadiazine	13.63	NA	<0.005	<0.01						
Sulfamethazine	1.86	NA	<0.005	<0.01						
Ciprofloxacin	5.10	0.1-1.1	0.009	<0.01						
Enrofloxacin	59.10	0-0.2	<0.005	<0.01						

A: One sample. Detection level is <0.005 mg/kg; NA: Not analysed

B: Four samples. Detection limit of 0.01 mg/kg; <0.01mg/kg means not detected.

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