Fate of Pharmaceuticals and Bacteria in Stored Urine and during Precipitation and Drying of Struvite

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Innovative Sanitation Systems

Introduction

- Phosphorus is a scarce resource with approximately 100 years lifespan
- Urine contains 50-65% of P and 80% of N of the daily excrementitious matter
- Pharmaceuticals are excreted and can mainly be detected in urine
- Urine may be a good fertilizer

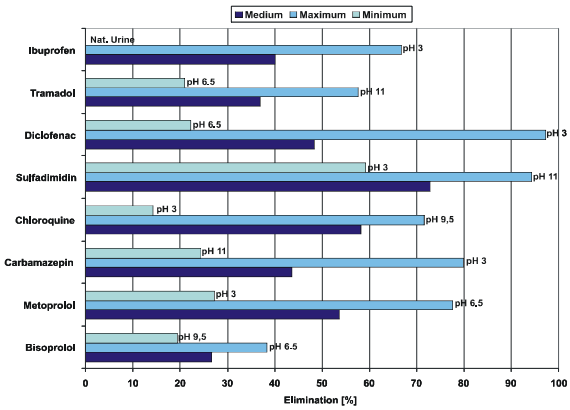
Aims of the Project

- Collection of urine in GIZ main building (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Eschborn)
- Storage of urine and precipitation as struvite for use as fertilizer
- Detection of pharmaceuticals at any stage of the process
- Behaviour of struvite during drying

Results & Discussion

Storage experiments

- Sampling of fresh urine from one of the storage tanks at GIZ
- Filling of twelve 5L brown glass bottles
- Adaptation of always two bottles to either pH 3, 6.5, 8.5, 9.5 or 11
- Spiking of one of the two bottles with 100 µg /l of each medicament
- Storage at 20°C in a dark place for 6 months



Elimination rates of pharmaceuticals in pH adjusted urine during six months storage.

Bottles for storage experiment (background) and transparent reference bottles for inspection of optical appearence

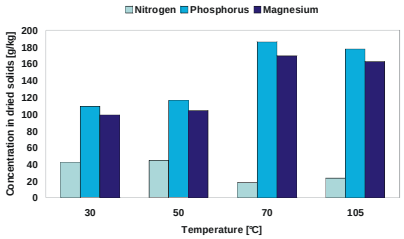
List of added medicaments

Medicine	CAS No.	Chemical Formula	Specification
Bisoprolol	66722-44-9	$C_{18}H_{31}NO_4$	beta blocker
Carbamazepin *	298-46-4	$C_{15}H_{12}N_2O$	anticonvulsant prevention of malaria
Chloroquine *	54-05-7	$C_{18}H_{26}ClN_3$	anti-inflammatory
Diclofenac	15307-86-5	$C_{14}H_{11}Cl_2NO_2$	antihypertenive
Hydrochlorothiazide *	58-93-5	$C_7H_8ClN_3O_4S_2$	anti-inflammatory
Ibuprofen *	15687-27-1	$C_{13}H_{18}O_2$	beta blocker
Metoprolol	51384-51-1	$C_{15}H_{25}NO_3$	beta blocker
Nebivolol	118457-14-0	$C_{22}H_{25}F_2NO_4$	veterinary antibiotic
Sulfadimidin	57-68-1	$C_{12}H_{14}N_4O_2S$	opioid analgetic
Tramadol	27203-92-5	$C_{16}H_{25}NO_2$	

* in WHO Model List of Essential Medicines (WHO, 2010)

Conclusion:
The adjustment of natural urine to any of the chosen pH values does not have comparable effects on every added medicament.

Experiments with struvite



Struvite crystals

Fate of pharmaceuticals in urine before and after precipitation and in non-washed and washed struvite

		Diclofenac	Hydrochloro-thiazid	Metoprolol	Nebivolol
Urine spiked	[µg/l]	106	101	115	114
Urine after precip.	[µg/l]	96	87	86	102
Struvite non washed	[µg/kg]	15	8	7,5	16
Struvite washed*	[µg/kg]	< LOD	< LOD	< LOD	< LOD

* washed with saturated struvite solution LOD: Limit of detection

Drying of strutive

- N, P and Mg content changes during drying of struvite
- Loss of N and crystal water at higher temperatures
- Temperature influences chemical composition

Bacteria in urine and struvite

- Urine from healthy people, well seperated from faecal matter and stored prior for the production of struvite is no infection source.
- Drying of struvite further reduces the number of microorganisms

Conclusions

Collecting urine and precipitation of phosphorus as struvite leads to a product free of pharmaceuticals and bacteria. Struvite is a good alternative to chemical fertilisers and protects phosphorus resources.

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