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

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Human urine contains 50-65% of the P of the daily excrementitous matter and 80 % of the N amount. Phosphorus is of essential importance for all biological systems, a main component of every fertilizer and plays a decisive role regarding the metabolism of energy. In this function it is not possible to abdicate phosphorus because it can not be substituted. Phosphorus is classified as a scarce resource with a static lifespan of about 100 years (Montag et al., 2009). Against this background the German Federal Ministry of Education and Research (BMBF) launched in 2009 the research project “SANIRESCH - Sustainable sanitary recycling Eschborn". Urine and faeces of app. 200 persons are continuously and separately collected and treated in the main building of GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH).

Main objective of the studies of ISA is the behaviour of pharmaceuticals (Bisoprolol, Carbamazepine, Chloroquine, Diclofenac, Ibuprofen, Metoprolol, Sulfamethazine, Tramadol) in spiked and non-spiked urine during 6 months of storage – according to the WHO guidelines (WHO, 2006). Storage is performed at different pH values and the fate of the pharmaceuticals and bacteria is observed during MAP (Magnesium Ammonium Phosphate = struvite) precipitation and the drying process. The urine sampled during the research project contained rather low concentrations of pharmaceuticals. It can not be excluded that samples from GTZ-building have previously been diluted with water. The preliminary results for the elimination of two different spiked pharmaceuticals during a storage time of 11 weeks are shown in figure 1.1.

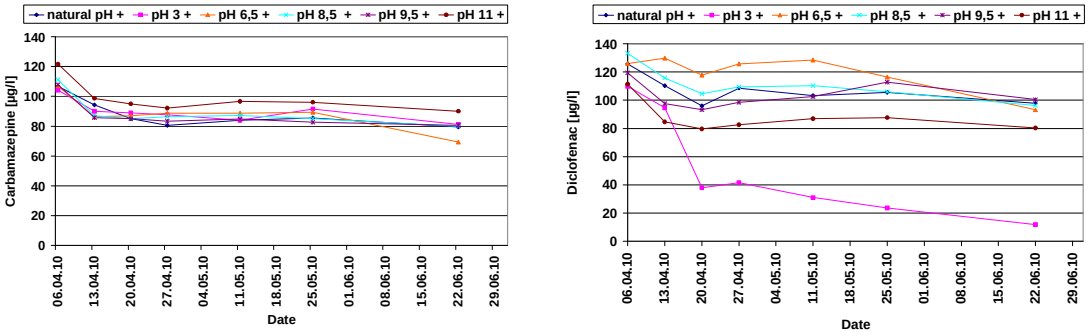

Figure 1.1 Decrease of Carbamazepine and Diclofenac concentration during urine storage at different pH-values.

While Carbamazepine shows at all pH-values a mean elimination rate of 27 % Diclofenac is eliminated at pH 3 by more than 80 %. This effect is based on a chemical decomposition at this pH value. Similar effects can be observed with Sulfamethazine at pH 11. It needs to be noted that a systematic alteration of pH in collected urine can not eliminate mixtures of pharmaceuticals because each medicament has different reactive groups and mechanisms of action.

As the recovery of phosphorus for agricultural purposes forms one of the project’s aims most of the collected urine was used to precipitate struvite crystals with MgO

that can easily be used as fertiliser. Preliminary studies with MAP crystals precipitated from urine with high concentrations of pharmaceuticals showed that the adhesive medicaments could be removed from the product with a saturated solution of MAP (Table 1.1). Additional experiments will be carried out with the natural urine from GTZ building having much lower concentrations of medicaments.

Table 1.1 Fate of pharmaceuticals in non washed and washed MAP

	Diclofenac	**Hydrochloro-thiazide**	**Metoprolol**	**Nebivolol**
	[µg/kg]	[µg/kg]	[µg/kg]	[µg/kg]
MAP non washed	15	8	7,5	16
MAP washed*	< LOD	< LOD	< LOD	< LOD
* washed with saturated MAP-solution LOD = Limit of detection				

The recovered MAP must be dried prior to the usage in agriculture. Drying experiments at different temperatures show the influence on the products composition and bacterial pollution. MAP was dried at 30℃, 50℃ and 70℃ (72h) as well as at 105℃ (24h). Figure 1.2 shows the effect on the concentration of nitrogen, phosphorus and magnesium of the dried product. There is the expected loss of nitrogen and chemically combined water at temperatures above 50℃ changing the products composition with respect to H_2O, Mg, N and P. The drying temperature influences the composition. The latter was reduced by 6 log units per g MAP with increasing temperatures.

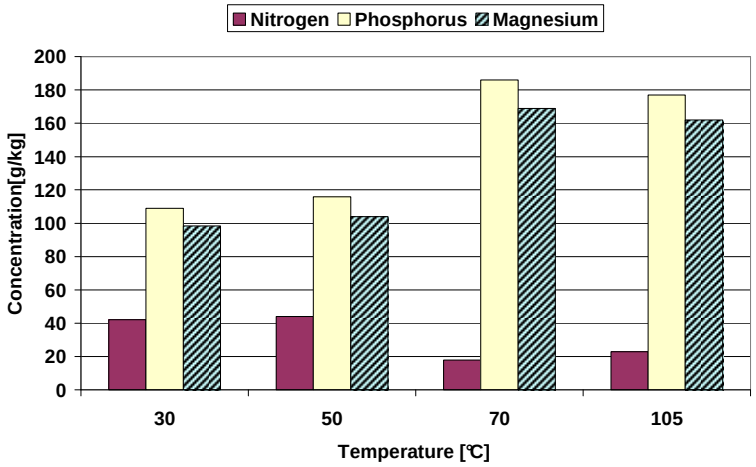

Figure 1.2 Nitrogen, phosphorus and magnesium concentrations in MAP after drying at different temperatures

The abstract shows that the received washed product produced in an innovative large scale urine collection and treatment system is sustainable and can be used in agriculture without bringing pharmaceuticals and bacteria into the environment. The full paper will deal with further results and discuss the relevance of this process for phosphorus recovery and possible emissions of pharmaceuticals in the environment.

References

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