

Recycling and Fertilizer Efficiency of Nutrients from Human Urine

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Research Objectives

- Develop and optimize treatment processes for generating the most favorable fertilizer substrates from source separated human urine.
- Characterize the generated products in terms of nutrient concentration, heavy metal contamination and plant availability of nutrients.
- Conduct greenhouse experiments and evaluate the impact of different test substrates on plant morphology and dry matter yield.

Human Urine – A Valuable Source of Nutrients

One of the 8 goals adopted at the UN Millennium Summit in 2000 refers to ensuring environmental sustainability, and to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation.

With the aim of achieving these Millennium Development Goals, and given the depletion of world rock phosphate reserves and increasing fertilizer prices, new holistic sanitation concepts focusing on economically feasible closed-loop systems were conceived.

The „NoMix“ technology aims at collecting the various wastewater streams separately at source and treating them individually with the objective of recovering nutrients and reusing the clarified water.



Human urine accounts for only around 1% of all municipal wastewater, but contains most of the nutrients:

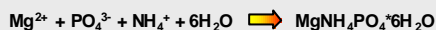
Parameter	Domestic Wastewater	Urine
Volume (L/person*year)	42000	1%
N (kg/person*year)	4-5	87%
P (kg/person*year)	0.75	50%
K (kg/person*year)	1.8	54%
Pathogenic Bacteria	+++	+

Source: Gajurel et al. (2003), Water Science & Technology/Vol 48 No 1 pp 111-118

The Recycling of Nutrients from Human Urine

I. Phosphorus Recovery

Phosphorus can be recovered by mixing the urine with magnesium, which binds with the phosphorus and the nitrogen. The generated precipitate is composed of struvite or MAP (magnesium ammonium phosphate), a solid mineral fertilizer.



II. Nitrogen Recovery

When the temperature and the pH of urine are increased, the nitrogen prevails in the form of volatile ammonia. Ammonia can easily be removed from the liquid phase through air stripping and subsequently be absorbed in sulfuric acid to form ammonium sulfate, a liquid fertilizer.



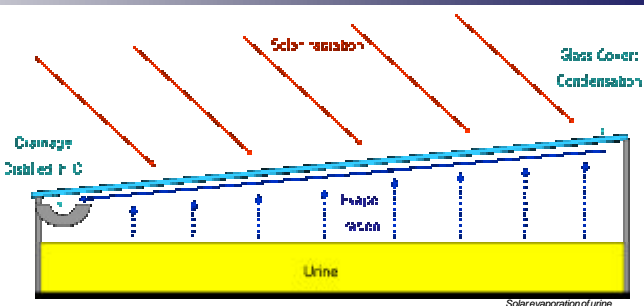
Materials and Methods

Process Optimisation

The processes of struvite precipitation, solar evaporation of human urine and air stripping are optimized in order to maximize the cost-efficiency of these novel technologies.

The optimum parameters which are necessary to generate a high plant availability of major nutrients need to be identified.

Laboratory-scale simulations of the above technologies will eventually provide the foundation for developing an industrial-scale treatment unit or for consulting and sharing the knowledge with operators.



Solar evaporation of urine

Substrate Characterisation

The substrates generated through urine processing are analyzed for the following parameters:

- Macro-Nutrients (e.g. Nitrogen, Phosphorus, Sulfur, Potassium, Calcium, Magnesium)
- Micro-Nutrients (e.g. Boron, Molybdenum, Iron, Manganese, Zinc, Copper)
- Heavy Metal Contamination (e.g. Aluminium, Arsenic, Lead, Cadmium, Chromium, Nickel)

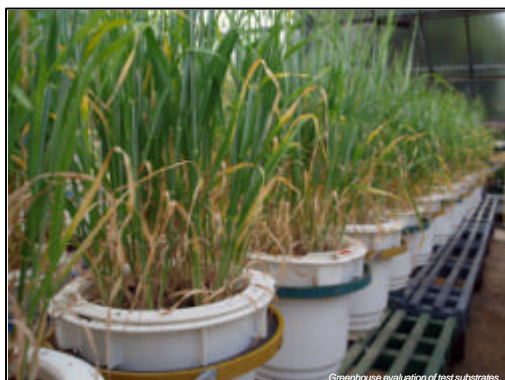
The nutrient availability of the substrates is assessed by using the following techniques:

- X-Ray Diffraction Spectroscopy (crystal structure)
- pH Stat Titration
- Phosphate solubility in mineral acid, in ammonium citrate, in citric acid and in water

Greenhouse Evaluation

A variety of innovative substrates are, under controlled conditions, applied to different test crops (e.g. ryegrass, clover, maize) and their fertilizer efficiency is compared to that of commercial mineral fertilizers.

Symptoms of nutrient deficiencies are recorded, the dry matter yield is evaluated, and the relative agronomic effectiveness is computed.



Greenhouse evaluation of test substrates