Science in Urine Handling and Utilization

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Abstract
One of the concepts of Sustainable Development Goal (SDG) 6 is providing source oriented sanitation. In this case and with respect to the high concentration of nutrients in human urine, utilizing it as fertilizer is an important concept as a part of resource oriented sanitation. In this paper, the scientific advancement of urine handling and utilization based on challenges of smell and scale formation is presented which is based on the identified goal of urine treatment to be utilized as fertilizer. Based on these advancements, possible implicates in the practice of resource oriented sanitation is introduced.

Keywords
Resource Oriented Sanitation; Sustainability; Urine Treatment and Management; Waste Onsite Treatment

INTRODUCTION
Sanitation is a worldwide problem. Lack of access to sustainable and suitable sanitation systems around the world made this concept to be a part of Sustainable Development Goal (SDG) 6. The ideal goal of this sustainable sanitation will be with urine separation, using less water and utilizing wastes as fertilization. In that sense, resource oriented sanitation is fits the goal of sanitation. Because of challenges like high volume, high amounts of nutrient, Pharmaceuticals and Protective Care Products (PPCP), managing urine is important. However, scientific knowledge in the life cycle process including collection, transport, storage, treatment and utilization of urine limits the wide adaptation of resource oriented sanitation. In this paper, scientific advancement of urine handling and utilization is introduced as concepts of smell and scale formation by identify the goal of urine treatment and disposal as utilizing sanitary wastes as fertilizer. Furthermore, possible implication in the practice of resource oriented sanitation is suggested.

IDENTIFYING THE GOAL OF URINE MANAGEMENT
Storage, treatment and disposal should be done by the goal of final utilization. Urine is a rich source of nutrients like nitrogen and phosphorous compounds and can be utilized as fertilizer. As nitrogen is the majority of urine and nitrogen profile in urine can change easily, modifying it is essential for making

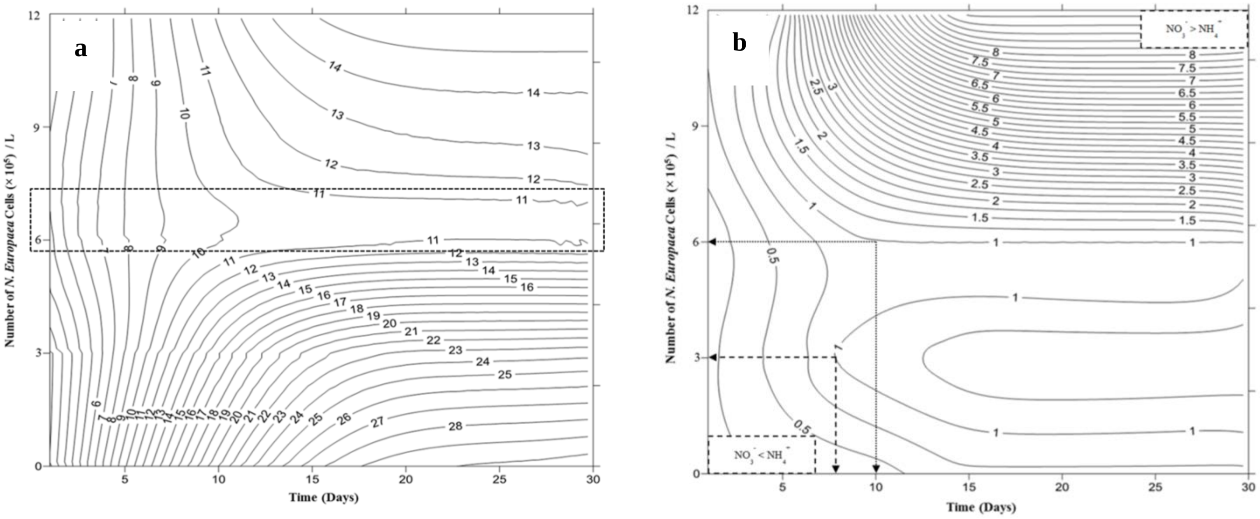

Figure 1. (a) Percentage of Nitrogen Loss at Different *N. europaea* Bio-seed Concentrations and Durations; (b) Nitrate : Ammonium ratio at Different *N. europaea* Bio-seed Concentrations and Durations

fertilizer from urine. Also controlling nutrient loss and smell are important challenges in urine management.

SCIENCE OF URINE

Challenges in Smell and Nitrogen Profile

Ammonia loss as gas is a critical issue in urine management. This is because not only losing ammonia is losing nutrients but also this loss is the main source of urine smell. Hashemi et al. (2016) study shows that adding 6×10^5 *nitrosomonas europaea* bio-seed Cells to 1 litter urine can control the ammonia lose and prevent smell as it is presented in figure 1. This study also yields that this dosage of bio-seed can make urine as a liquid fertilizer which has the characteristics of the European Commission standard by modifying the ratio of NH_4^+ to NO_3^- as 1:1. This means that not only the nutrient loss reduces but also this onsite treatment can produce a ready-to-use fertilizer from Urine.

Challenges in Scale Formation

Urine scale formation is affected by Total Dissolved Solids (TDS) and pH, which are different in flushing with different types of water. This can be explained by a simple pC–pH diagram. Figure 2 presents the saturation situation of urine and urine mixed with different flushing water based on concentration of calcium ion in calcite formation. Flushing with high TDS water such as seawater makes urine more supersaturated and increases the potential of urine scale formation (Arrow 1). Although flushing with tap-water reduces precipitate composition it increases the pH and requires high volumes of water to make it unsaturated (Arrow 2). In contrast, flushing by rainwater results in a lower Ca^{2+} concentration and lower pH; the Ca^{2+} is under-saturated stopping scale formation in this region (Arrow 3). Another way to reduce urine scale formation is reducing pH of flushing water (Arrow 4) (Hashemi et al. 2015).

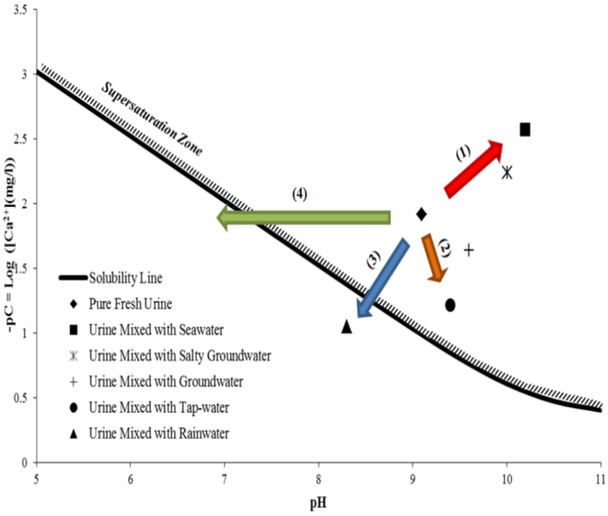

Figure 2. Precipitation Process of Calcium versus pH (Dilution Rate = 1:8; Temp = 25 ^oC)

PRACTICAL IMPLICATES

These advancements can serve as a basis for criticism of several practices, as well as a suggested solution. In this case, flushing with high TDS water such as seawater, which is practiced by Hong Kong authorities, increases the potential of urine scale formation. Also by modifying the nitrogen profile using nitrifying bacteria or diluting urine with lower pH and TDS it is possible to overcome smell problems which is caused by high concentration of ammonia. Among all available flushing water, using rainwater can be introduced as the best choice as it can reduce the TDS and pH of urine at the same time.

CONCLUSION

Scientific advancement in urine treatment and management on the challenges of smell and scale is presented. As the goal of urine treatment is utilizing it as a fertilizer, the methods of these advancements are on the way of this goal. Possible implication in the practice of resource oriented sanitation is introduced. By the advance of urine science, we can promote more to ROS by improving current problems and challenges in sanitation.

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