REUSE OF NUTRIENTS FROM ECOLOGICAL SANITATION TOILETS AS A SOURCE OF FERTLISER

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ABSTRACT

The high nutrient levels in human excreta especially in the urine are a well-established fact. Equally true is the use of human excreta a fertiliser or soil conditioner since time immemorial in some ancient societies such as the Chinese. In many cases the use of treated or that of treated wastewater has been common in the faecal phillic rather than faecal phobic communities. There is current push to go back to this phenomenon due to the good quality fertiliser obtainable free from chemicals especially heavy metals. As well as the prohibitive costs of chemical fertilisers that are causative to destruction of the natural environment.

In this study an attempt is made to show the possibility to collect, treat, store and use of human excreta as a nutrient subsidy for the soil. Twenty-eight sampling points were used in this study. Concentrations of nitrogen, phosphorus and potassium in urine were determined from samples obtained from different ecological sanitation toilets located in Ukonga, Dar es Salaam Tanzania. The results have demonstrated that human urine contains large proportion of nitrogen and phosphorus, which can therefore be used as a fertiliser in cases where other fertilisers are either costly or inappropriate. Concentrations of nitrogen and phosphorus between 200 mg/l to 2000 mg/l and from 3 mg/l to 90 mg/l respectively were observed.

KEYWORDS:

Nitrogen, phosphorus, ecological sanitation toilets, reuses

INTRODUCTION

Conventional waterborne sewage system has proven to be inappropriate to solve the sanitation needs in developing countries. Only wealthier upper-and middle class areas are normally provided with those services. Approximately 90% of the sewage in cities in developing countries is today discharged untreated, polluting rivers, lakes and coastal areas (Winblad, 1997). Conventional pit latrines have certain limitations, especially in densely populated areas with risks of contamination of groundwater. Many cities are short of water and subject to critical environmental degradation (Niemczynowicz, 1996). Their peri-urban areas are among the worst polluted and disease ridden habitats of the world. Sewage discharges from centralised waterborne collection systems pollute surface waters and seepage from sewers, septic tanks and pit toilets pollute groundwater. Conventional sanitation technologies based on flush toilets, sewers, treatment and discharge cannot solve these problems in urban areas lacking the necessary resources such as water, money and institutional capacity. The range of policy options in sanitation should be widened to include ecological alternatives.

Ecological sanitation technologies take the principle of environmental sanitation a step further: Environmental sanitation means keeping our surroundings (the environment) clean and safe and preventing pollution. It includes wastewater treatment and disposal, vector control and other disease-prevention activities. Ecological sanitation, on the other hand, is structured on recycling principles. It means keeping the eco-cycle in the sanitation process closed. It is also a low-energy approach that uses natural processes. Ecological sanitation (also called "Ecosan") is a cycle, or closed-loop system, which treats human excreta as a resource. In this system, excreta are processed on site until they are free of pathogenic (disease-causing) organisms. Thereafter the sanitized excreta are recycled by using them for agricultural purposes. Key features of Ecosan are therefore:

- Prevention of pollution and disease caused by human excreta;
- Treatment of human excreta as a resource rather than as a waste product; and
- Recovery and recycling of the nutrients.

Conventional approaches to sanitation misplace these nutrients, dispose of them and break this cycle. The very idea that excreta are waste with no useful purpose is a modern misconception. It is at the root of pollution problems that result from conventional approaches to sanitation. In nature there is no waste – all products of living things are used as raw materials by others (Esrey *et al*, 1998). Recycling sanitised human urine and faeces by returning them to the soil serves to restore the natural cycle of life-building materials that has been disrupted by our current sanitation practices. These principles are not new. In some cultures, for example in parts of East Asia, ecological sanitation systems have been widely used for hundreds of years, and in the case of China, for a few thousand years. It is important, however, that these systems are not regarded merely as a second-rate solution for poor people. Ecosan principles may be applied across a range of socio-economic conditions.

The excellent fertiliser value of human excreta origin has been well established. Humans excrete, on average, sufficient plant nutrients in the forms of nitrogen, phosphorus and potassium to grow the 230-kg of crops they need annually, with approximately 65 to 90% of the nutrients being found in urine. Furthermore, these nutrients are in chemical compounds easily accessible to plants. In most countries of the world, use of human excreta as fertiliser has been implemented only to a very limited extent. Rather, they have been flushed out into the rivers with consequent growth of algae, etc, resulting in a lack of oxygen in the aquatic resources. These resources have also been polluted with pathogenic microorganisms to the extent that many rivers have become virus/bacterial infected more or less permanently. It is thus better to create a closed system, with no pollution from bacteria or viruses and where human fertilisers are harvested and used to grow the following year's crops.

METHODOS AND MATERIALS

A total of twenty-eight ecological sanitation toilets with urine diversion design were constructed in different places of Ukonga majumba sita in Dar es Salaam. Plate 1 shows typical ecological sanitation toilet. Measurements were made on samples of urine collected from these toilets. Physical-chemical parameters were analysed in water quality laboratory at the University of Dar es salaam.

Plate 1: Ecosan toilet at karakata primary school in Dar es Salaam

While pH was measured *in situ*, total Kjeldahl nitrogen (TKN), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), phosphorus (P), potassium (K), chemical oxygen demand (COD), and total suspended solids (TSS) were measured in the laboratory in accordance with *Standard Methods* (1992).

pH was measured by Metrohm pH meter model 704. TKN was determined by Semi-Micro-Kjeldahl Method. Cadmium reduction and diazotization methods were used for determination of NO_3-N and NO_2-N, respectively. Phosphorus was determined by ascorbic acid method, COD was analysed using closed reflux titrimetric method and TSS was measured gravimetrically after filtration and drying in oven at 105^{o}C. Potassium was analysed by atomic absorption spectrometry meter.

RESULTS AND DISCUSSION

Table 1 summarises the mean concentrations for physico-chemical parameters of urine from ecological sanitation toilets. The values in parenthesis are the standard deviations.

Table 1: Physico-chemical parameters

pH	8.88 (0.18)
TKN (mg/l)	645.24 (479.19)
NO_3 (mg/l)	171.06 (30.00)
NO_2 (mg/l)	9.43 (5.83)
TN (mg/l)	825.73 (502.20)
P (mg/l)	28.72 (28.36)
K (mg/l)	166.43 (82.51)
COD (mg/l)	3900.00 (658.22)
TSS (mg/l)	1962.50 (350.20)

The mean daily estimation of the amount of nitrogen, Phosphorus and potassium from urine, which are the main component of fertilisers, are shown in Table 2.

Table 2: The amount of nutrients in urine

TN (g/ca,d)	1.131
P (g/ca,d)	0.039
K (g/ca,d)	0.228

From Table 2, the reported values are lower compared to the measured values reported in Sweden (Jonsson *et al* 1997). In their findings, N, P and K in urine were 4.9g/ca,d, 0.42g/ca,d and 1.34g/ca,d respectively. This discrepancy might be due to type of food, which vary from place to place depending on the income. If a household has an average of 5 inhabitants, the amount of nitrogen, phosphorus and potassium from household produced from urine is 5.66g/d, 0.20, and 1.14g/d respectively. In Sweden the total yearly production of human urine contains nitrogen, phosphorus and potassium equivalent to 15-20% of the amounts of these nutrients in the mineral fertilisers used by agriculture (Jonsson *et al* 1997). The amount of nutrients found in this study contains high proportion of nutrients as compared to most chemical fertilisers found in the market in Tanzania. A typical 50-kg bag of chemical fertiliser contains 20%, 10% and 10 % of nitrogen, phosphorus and potassium, respectively and if correctly used can yield 25 bags of 100kg maize. From this research it is estimated that household urine on average produces 1.5-20% of these chemical fertiliser nutrients. This has a slightly deviation from Swedish findings.

CONCLUSSION

Using ecological sanitation toilet with urine deviation design can lead to serving of a significant amount of money which would have been used to buy chemical fertilisers. Compared with other sewage products, source separated urine have hygienic advantages because only few pathogens are excreted through urine. In this study faecal coliforms found in urine were only between 20-80 No/100ml which were assumed to die with storage time (probably in few days). If ecological sanitation could be adopted on a large scale, it would protect our groundwater, streams, lakes and seas from faecal contamination furthermore, farmers would also require less commercial fertilisers, much of which washes out of the soil into water, thereby contributing to environmental degradation.

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