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Title	**Urine treatment and use in the Andes**
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Treatment and use of urine in the Ecuadorian Andes

Introduction

ECOSAN (Ecological Sanitation) technologies are not widely used in Ecuador, although in rural areas there is a big potential for ECOSAN solutions. On one hand, organic fertilizers are preferred for cropping and there is a lack of sanitation in rural zones. On the other hand, ECOSAN promotion in these areas has shown a high level of population acceptance and motivation to use ECOSAN technologies. Some projects have been implemented in the country with successful results, but there is a knowledge gap about faeces and urine treatment and use in local conditions. Urine separation, its treatment and use play a basic role for ECOSAN. The use of urine in agriculture demands its previous sanitation. Several papers have been written about treatment, application and pathogens survival in urine. However, research has been generally done in European countries. Therefore, it is important to study urine and faeces treatment for local conditions in order to assist people in the use of ECOSAN technologies in an effective way. This paper discusses urine treatment and use in the Andean region of Ecuador. Weather conditions in Ecuador differ radically from those in the northern and southern hemispheres. In Ecuador, there are only two seasons during the year, the dry and the rainy seasons. Quito, the capital of the country, is located at an altitude of 2800 m. The annual average temperature is 13,4 °C during the year, but there are strong temperature variations in a day, going from 1,5 °C to 29,9 °C. The average annual precipitation is 1200 mm. The humidity is around 65 - 85% (Pourrut, P., 1995). The main objective of this research is to determine the local conditions for urine treatment and use. The main research questions are: when urine is ready to use, how long the urine has to be stored until it reaches a pH value of 9, there are visual changes in plants that are fertilized with urine compared to those without this fertilizer.

Methodology

This experiment was done at a house level simulating a simple dry toilet with urine diversion. Urine was collected and stored in transparent plastic bottles. The bottles were stored in different environments and temperatures. Temperature and pH values were constantly monitored through a thermometer and color-fixed indicator sticks, respectively. This two parameters were monitored until the urine had a pH value of 9, considering that pathogens survival in urine are limited for pH values of 9, as well as they were compared with regard to changes in temperature, storage and dilution (JØrgensen L.T., 2003)

The experiment had two phases. First, three samples of 500 cc were taken. The first two samples were collected in one day, while the third was collected in 3 different days. The pH

value was measured every month. When samples reached the desired pH value, they were diluted in water at a rate of 1:2 and applied to ornamental flowers.

Second, a 1500 cc bottle of urine was stored until the pH value reached 9 in order to fertilize fast-growing vegetables. For this purpose, three vessels divided into two parts each were seeded with lettuce and radishes. One part of each crop was not fertilized in order to have a parameter to compare with. The other parts received different urine-water dilutions at different growing stages.

Results

First phase of the experiment:
The characteristics of the samples were:

- Sample 1: initial pH value of 7, located in a dark place with a plastic cover and at almost constant temperature of 18 °C. The maximum temperature was 20°C. There was some oxygen left in the bottle. This sample reached the pH value of 9 in four months, and the color of the sample was lightly orange and had a bad odor.
- Sample 2: initial pH value of 7, located in a bright place at a temperature range of 24 °C to 29,5 °C. The maximum temperature was 30°C The bottle was full. The pH value of 9 was reached in two months. The color of the sample was red orange and the odor was unpleasant.
- Sample 3: initial pH value of 6,5, located in a bright place at a temperature of 18 °C. The maximum temperature was 21°C The bottle was full. After six months this sample did not reach the pH value of 9.

The characteristics of the plastic bottles also changed: at the beginning, they were rigid whereas they became flexible like a balloon full of water when the samples had a pH value of 9.

A dilution of 1:2 was done in urine when it was ready to use (in terms of pH). Urine was used to fertilize carnations, tulips and geraniums. After a month their green color was intense. Plants grew faster and were flowered longer.

Second phase of the experiment:
The second phase was started to prove the benefits of fertilizing crops with urine. Urine was used to fertilize fast-growing vegetables. A 1500 cc bottle of urine was collected and stored. Storage conditions were similar to sample 2. After three months, the pH value of the sample was 8 and the color started turning to orange.

Conclusions

- Sample 2, which was in a warm place (24°C), reached a pH value of 9 in half of time of sample 1 which was in a template place (18°C).
- Color intensity of the sample, when pH reaches the value of 9, is related to sunlight, since sample 1, stored in a dark place, had a lighter color than sample 2, which was stored in a bright place.
- The pH value variation influences changes in the plastic bottle characteristics used to store urine.
- More research in this field is required, since there are no precise rules for people to make sure that urine is ready to use as a fertilizer. Also, the best dilution factor for each crop must be analyzed. However, it can be said that when urine is stored in a transparent content, color changes can help to know when urine can be used.

- The enlargement of this house experiment to other regions of the country and other countries could help to exchange results and provide a better idea about urine agricultural use to the fertilizer users.