Citrullus lanatus seeds as a urine catalyst for anthroponics use

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Citrullus lanatus seeds as a urine catalyst for anthroponics use

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Abstract

Anthroponics is a recirculating soilless agriculture system that uses natural bacterial cycles to convert human biowaste such as urine into plant fertilizer. One main issue with the sterilization of urine before use in an anthroponic system is a waiting time of 4 to 5 weeks.

Two experiments were conducted. The first required three jars, each containing 100mL of fresh urine. Jar 1 was kept as control, Jar 2 had 1g of crushed and dehusked watermelon seeds added, and Jar 3 had 10g added. The pH of the solution was then measured 3 minutes after the initial moment of seed insertion and 20 minutes after. Jar 1 maintained its initial pH of 6,86 through both measurements, while both Jar 2 and Jar 3 achieved a pH greater than 9,0 at the end of the second measurement.

The second experiment attempted to predict the time when the pH level would be equal or greater than 9,0 after adding and mixing one crushed and dehusked watermelon seed. One jar containing 678mL of fresh urine was collected, and one crushed and dehusked watermelon seed was added and mixed. Over the period of 30 minutes the pH levels were measured every 5 minutes, and the values were plotted, thus correctly estimating the waiting time to be of 587 minutes, or 9,8 hours, confirmed later by another pH reading.

In conclusion, the volatilization time was reduced from 4 to 5 weeks to hours, minutes or seconds depending on the amount, giving great control in the manipulation of the volatilization time using a cheap and renewable resource.

Keywords: Anthroponics, aquaponics, human urine, hydroponics, nutrient recovery, wastewater treatment.

1. Introduction

Anthroponics can be defined as a recirculating soilless agriculture system that uses natural bacterial cycles to convert human biowaste such as urine into plant fertilizer. As stated in the author's report *Lactuca sativa production in an Anthroponics system* (Sanchez, 2015), the ammonia volatilization from urea takes between 4 to 5 weeks. This is the time it takes for the pH to increase to a value equal or greater than 9,0, sterilizing the urine by reducing its bacterial population while at the same time converting the urea to ammonia (Pradhan *et al*, 2007). According to Tisdale *et al* in *Soil fertility and fertilizers*, the reaction can be shown as follows:

$$(NH_2)_2CO\ (aq) + H_2O\ (l) \xrightarrow{\text{urease}} NH_3\ (aq) + H_2NCOOH\ (aq) \rightarrow 2NH_3\ (g) + CO_2\ (g)$$

As seen in the reaction, the urease enzyme is a catalyst that can increase the speed of the reaction. In effect, other researchers have shown how to use watermelon seeds to characterize urease (Prakash & Shushan, 1997) as well as how to immobilize the urease enzyme from watermelon seeds for urea estimation (Prakash *et al*, 2007).

Without access to the laboratorial techniques described in the previous papers regarding urease from watermelon, it should still be possible to use the urease present in the same seeds through a simple dehusking and crushing process. The following report aims to show that such method can work and can be a viable process for use and design of anthroponic systems.

2. Materials & Methods

2.1 First experiment

Three food glass jars were cleaned and repurposed for the experiment. 400 jubilee watermelon seeds were purchased (*Citrullus lanatus*) and stored at 4ºC in a refrigerator. The seeds were dehusked with a pair of pliers, and were crushed using a marble herb grinder. The crushed seeds were weighed using a standard kitchen scale, and the pH was measured using the following electronic pH meter: HM Digital waterproof PH-200.

The three jars were each filled with 100mL of fresh urine, from the same individual and the same urination event. Each jar had its pH measured before adding the crushed and dehusked seeds. Jar 1 was kept as control and no seeds were added, while Jar 2 had 1g added and mixed, and Jar 3 had 10g added and mixed. The pH was measured a first time 3 minutes after the seeds were added and a second time 20 minutes after the seeds were added. The results were summarized in Table 1.

2.2 Second experiment

For the second experiment, one jar containing 678mL of fresh urine from the same individual and the same urination event was collected, and one crushed and dehusked watermelon seed was added and mixed. Over the period of 30 minutes the pH levels

were measured every 5 minutes, and the values were plotted. From its equation, it was possible to estimate when the pH level would be equal or greater than 9,0.

3. Results

For the first experiment where different amounts of seeds were added, the results are summarized in Table 1 and plotted in Figure 1.

Table 1. Values of pH in all three jars (with Jar 1 being the control), before and after adding the dehusked crushed watermelon seeds

	Volume of urine (mL)	Seeds added (g)	Initial pH	pH after 3 minutes	pH after 20 minutes
Jar 1	100	0	6,86	6,86	6,86
Jar 2	100	1	6,81	7,33	9,25
Jar 3	100	10	6,84	9,07	9,52

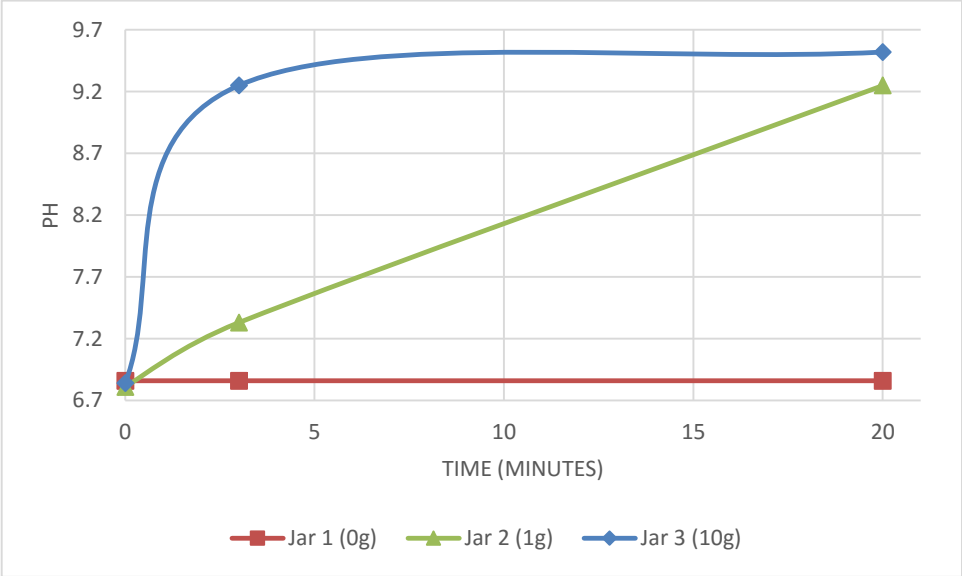

Figure 1: Change of pH levels over a period of 20 minutes after adding crushed and dehusked watermelon seeds. All jars contain 100mL of fresh urine each.

For the second experiment where only one watermelon seed was added, the change of the pH levels can be viewed in Figure 2. Throughout the measurements, the solution was stirred manually to help mix the crushed seed particles.

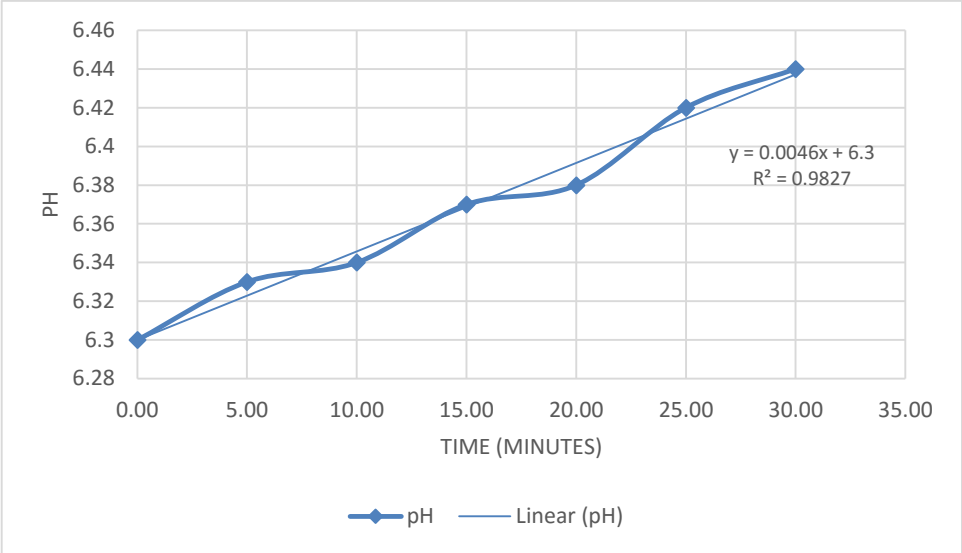

Figure 2: Change of pH levels over a period of 30 minutes after adding one dehusked and crushed water melon seed.

According to the linear regression equation, the solution would achieve a pH of 9,0 after 587 minutes, or ~ 9,8 hours. After the calculated time passed, a final pH measurement was conducted, indicating a pH level of 9,11.

4. Discussion and conclusions

As seen in in Table 1 representing the first experiment, adding watermelon seeds speeds up the pH change of the solution. Jar 1 (control) stayed consistent, which was expected. It is also seen that adding different amounts of seeds affected the pH change, with a greater amount of seeds decreasing the time needed to bring the pH to 9,0. We can draw this conclusion by comparing the pH in Jar 2 (1g) and Jar 3 (10g) at the 3 and 20 minute mark, where the pH in jar 3 is higher in both cases. Depending on how fast pH changes are needed, a higher amount of crushed seeds can be added, however because 1g of watermelon seeds brings the pH up to 9,0 within 20 minutes this amount should be sufficient for most needs.

Experiment 2 is represented in Figure 2 where one crushed watermelon seed was added and the pH change recoded over a 30 minute time period, and finally a linear regression was calculated. Based on this linear regession, the pH would reach a level of 9,0 after about 9,8 hours. However, it should be noted that this time estimate may be misleading since the observed pH change in this experiment is small (0,15 over the course of 30 minutes). Thus the linear regression is drawn from a relatively small timeframe and pH change to properly apply it to a 9,8 hour timeframe.

Applying the linear regression to a 9,8 hour timeframe assumes that the enzymes function in a uniform way over a long period time and large pH span. It is possible that the changes in pH do not occur in such a linear process since a certain pH might cause the enzymes to denaturate or not be able to work at their optimal rate. This can have many effects, such as the pH leveling out into a plateau before even reaching a pH of

9,0 or the pH change slowing down so much that it takes significantly more time than 9,8 hours for the pH to reach 9,0. Ideally the experiment should be repeated several times over the time period it takes for the pH to reach the wanted level.

A possible concern with the method in these experiments is that the sample size is too small for statistical relevance. If further experiments within this area are done it is important that that the experiments are repeated with a bigger sample size, and if possible using urine samples from different individuals. However for the aim of this experiment, which was to find out if watermelon seeds may be a viable method of increasing pH change, a small sample size can be accepted.

In conclusion, the experiments have supported the hypothesis that watermelon seeds contain urease and that they can be used to dramatically increase the aging process of urine for anthroponic use. This significant reduction in time (~99% reduction in time) needed for the volatilization of the urine paves the way for bigger applications of anthroponic systems, as the system design no longer needs to incorporate ageing reservoirs for the 4 – 5 weeks waiting time.

While watermelon seeds are a relatively cheap and renewable resource, they are more expensive than other potential sources of the urease enzyme, such as yellow peas and jack beans. As such, further research should also explore and compare alternative sources of urine catalysts so as to best understand the benefits and hindrances of each one.

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