



Preliminary Feasibility Study on Urine Reuse as Nitrogen and Water Source for Corncob Composting

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ABSTRACT

This work studied the feasibility of the use of urine instead of water for adjusting moisture content of composting. In addition, urine is also nitrogen source for composting. Corncob, an agricultural waste, was used as composted material. Experimental tests of composting used two 34 L-thermal plastic reactors with polystyrene as insulator and supplied air at the rate of 320 m³/hr. One reactor used to compost corncob, grass with water mixture. The other used to compost corncob, grass with urine mixture. The parameters were observed every week, which were temperature, moisture content, volatile solids, pH, electrical conductivity, nitrogen, phosphorus and potassium. The both of composts were tested by plant growth and Pakchoy was used for plant test. The plants were sampled every ten days about two months and the weight of plant, the height of stems, the width of leaves and the length of leaves were measured. The results of plant growth showed that the plants grew in urine-compost better than the plants grew in water-compost.

The urine reuse can be instead of water for moisture content adjustment and also as nitrogen source for composting.

INTRODUCTION

The purpose of this research was to study reuse of urine that urine can use as water and nitrogen source instead of water and urea in composting.

Composting is an aerobic biological process to degrade the organic materials and also to transform the organic material to useful products (compost). The majority function of compost is acted as fertilizer and soil conditioner [1]. The characterizations of compost are light, stable, cation exchanger, porous and humified materials [2]. The water is one



of key parameter for adjusting optimum moisture content. The use of fresh water in composting unnecessarily increases water consumption. Therefore, the use of alternative water resources should be done. The alternative water resources are yellow water (urine), greywater (dishwash water, laundry water) and stormwater.

Urine is a source of plant nutrients containing approximately 1.5-2 kg nitrogen, 0.15-2.0 kg phosphorus and 0.4-0.5 kg potassium per person per year [3]. These nutrients are in a form readily available to plants [4]. Urine diverting is a technique to recycling nutrient and decreasing water consumption in some activities such as watering plant and lawn [5].

Agricultural residues are alternative materials, which are available locally inexpensive and abundant manner such as corncob, bagasse and straw [6]. The agriculture residues are carbon sources of the composting.

One research about urine composting studied several composting experiment using carbon source materials were grass, leaves, fruit peels, coconut fiber mixed with different nitrogen sources: urine and soy bean meal (residue from soy milk production) [7]. They found that the average values of the indicated components in the compost product with urine, soybean and control were 1.35%, 1.56% and 1.07% nitrogen respectively; 0.21%, 0.03% and 0.07% phosphorus respectively; and 0.74%, 0.76% and 1.09% potassium respectively.

METHODS

Preparing Materials

Corn cob, waste materials from fresh market, was used as raw materials. It was cleaned by water, dried at 105 °C for 6 hours, and then grounded. Grounded corncob was mixed with grass, microbial mixture as inoculant and urea solution in one reactor and the other use urine instead of urea solution. The corncob mixtures were put into the 34-L polystyrene-insulating plastic reactor. Air was applied intermittently every 15 minutes.

Composting Studies

Sampling was collected every week. Temperature was measured every day. The key parameters of composting were analysed: moisture content, volatile solids, pH, and electrical conductivity.

Plant Nutrient Studies [8]

Nitrogen Content

Nitrogen analysis in this experiment used Kjeldahl method. Weight compost 0.5-1.0 g. and added sulfuric acid 20 ml, then digested with Kjeldahl digestion apparatus at temperature 100-400 °C for 2 hours until clear solution was appeared. The clear solution was distilled, and the Erlenmeyer flask, added boric acid 50 ml. with 4-5 drops



of mixed indicator, was used to collect the distillate. The distillate was titrated with standard hydrochloric acid and the end point changed the sample solution colour from green to purple.

Phosphorus Content

Phosphorus analysis in this experiment used Vanadomolybdate (Barton) method. Pipette 5 ml. of clear solution from digestion in total nitrogen analysis, added Barton solution 5 ml. and added distilled water to 25 ml. in volumetric flask. The sample solution was mixed and placed at least 30 minutes and then measured the sample solution colour by Spectrophotometer at 420 nm.

Potassium Content

Potassium analysis in this experiment used Flame photometry analysis method. Pipette 5 ml. of clear solution from digestion in total nitrogen analysis, then diluted with distilled water until the potassium content in the sample solution was in the range of standard curve of potassium standard. The sample solution was analysed by Flame photometer.

Plant Growth Test Studies

Pakchoy (*Brassica campestris* var. *chinensis*) was used for plant growth test in this experiment. This experiment was set into 3 treatments: (1) Soil as control; (2) Soil and composted material with urea; and (3) Soil and composted material with urine. Every 60 Pakchoy seeds were put in each treatment. One litre of water was watered in each treatment once per day for two months. Three Pakchoys were sampling in each treatment every 10 days for two months. The weight of plants, the height of stems, the width of leaves and the length of leaves were measured.

Statistical analysis

The experiment was designed by completely randomised design (CRD) with 3 duplicate for analysis. The results were compared mean by Duncan's new multiple range test (DMRT) with hypothesis at confident interval of 95 % using SPSS v.11 packaging software.

RESULTS

The experiments were divided into two parts: composting study and plant growth test.

Composting study

The key parameters of composting which were temperature, moisture content, volatile solids content, pH, and electrical conductivity were studied as shown in Figure 1-5 and the plant nutrients were nitrogen content, phosphorus content, and potassium content also were studied as shown in Figure 6-8.

The key parameters of composting results

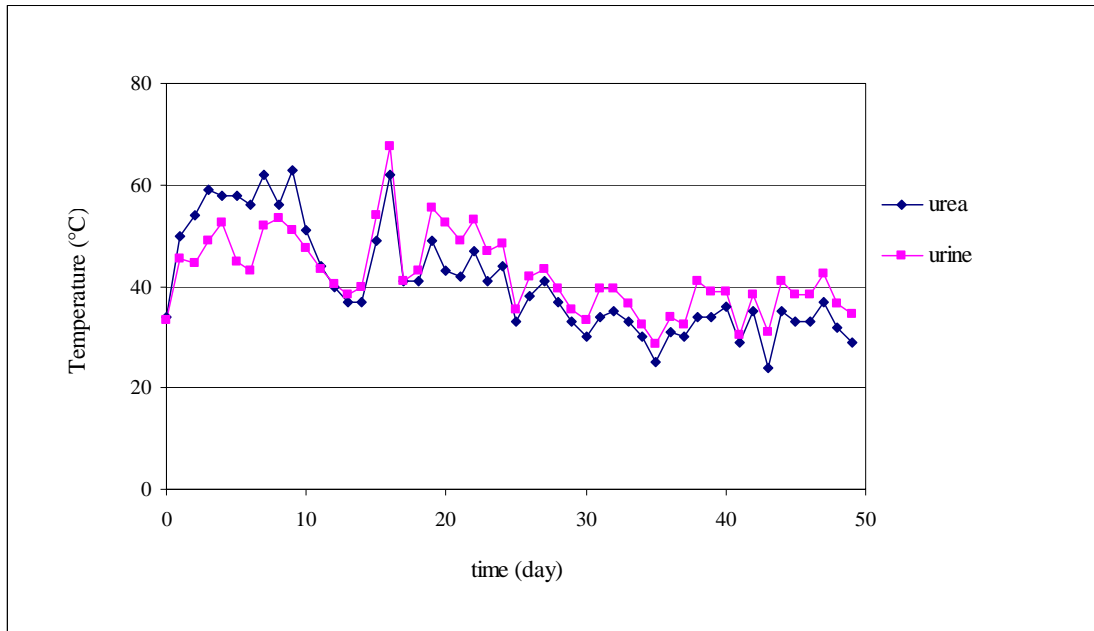


Figure 1. Effect of temperature during composting.

Figure 1 showed the temperatures were measured every day. The temperatures increased from 33.5 °C to 55 °C in 3 days and kept them constant to day 9 because the simple organic molecules were degraded by microorganisms. They produced heat with the stable organic materials, water, carbon dioxide and heat accumulated in the composting material. After day 9, the temperatures decreased to 40.5 °C until day 14, probably because the complex organic molecules started to degrade, which were difficult to degrade by microorganisms. Then, the temperatures increased to 67.5 °C for two days. After day 16, temperatures continually decreased but kept them constant periodically from 55.5 °C to 25 °C throughout the process. The urea solution and urine were added in each reactor at the end of the process but the temperatures were not increased. This effect meant the composting finished.

Temperature affected to the percentage of moisture content. The heat mostly used for evaporating water from composting materials. Figure 2 indicated that the moisture slightly increased from 76.65 % to 84.92 % in 30 days and then slightly decreased to 81.24 % for the reactor adjusted water with urea solution. While the moisture content in the reactor adjusted water with urine increased from 65.82 % to 80.60 % in 20 days and then kept it constant throughout the process. The high moisture content of the experiment probably had from 2 reasons. One is the nature of corncob which is porous materials. This property can absorb water in the pores of materials which make high moist materials. The other is from the water which produced from the process.

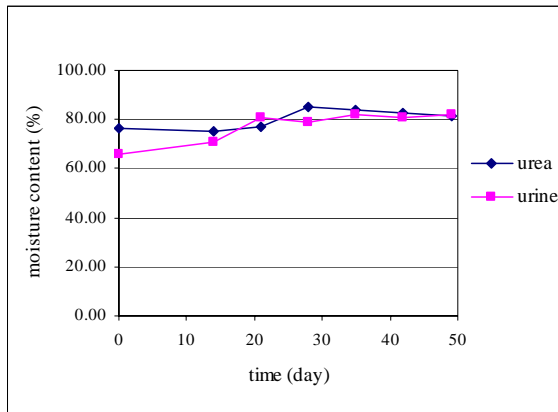


Figure 2. Effect of moisture content during Composting.

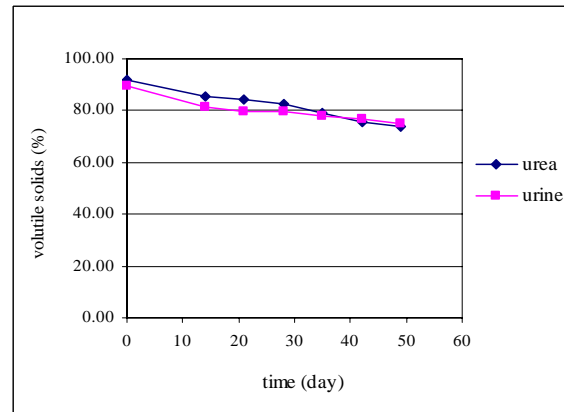


Figure 3. Effect of volatile solids during composting.

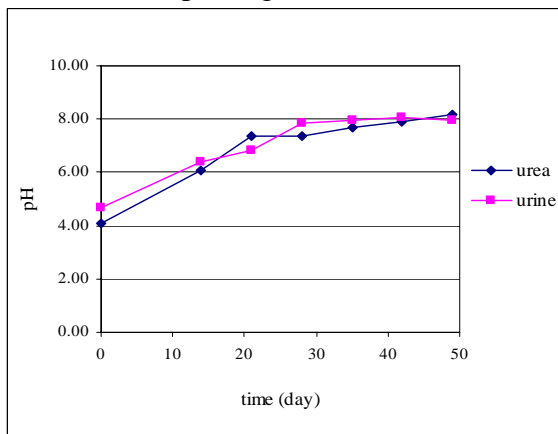


Figure 4. Effect of pH during composting.

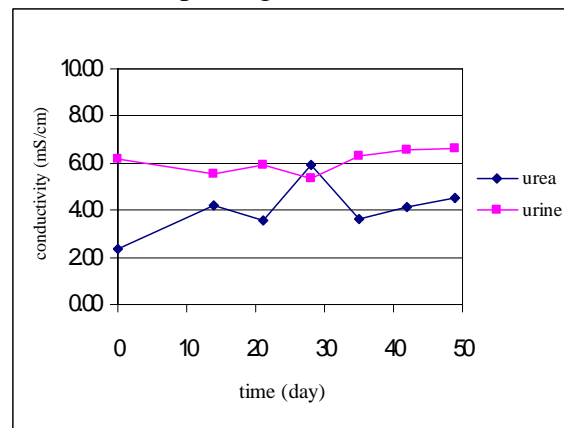


Figure 5. Effect of electrical conductivity during composting.

Figure 3 showed the volatile solids of the both reactors slightly decreased from 90 % to 74 % along the process because the simple organic molecules were degraded and transformed carbon to stable organic matter and carbon dioxide gas. In addition, the corncob consists of highly cellulose, lignin and strongly structure, which is difficult to degrade by microorganisms although the inoculants were added.

pH increased about from 4.0 to 8.0 along the process as shown in Figure 4 which are in the optimum range pH for composting. The pH increased along the process probably affecting of urea in urea solution and urine.

The results of the electrical conductivity were shown in Figure 5. The electrical conductivity in the reactor adjusted water with urine slightly decreased in 30 days from 6.2 ms/cm to 5.4 ms/cm and then increased from 5.4 ms/cm to 6.5 ms/cm in the last 20 days. While the electrical conductivity in the reactor adjusted water with urea solution was fluctuated along the process. The electrical conductivity showed the amount of the electrolyte in the composted materials.

The plant nutrients results

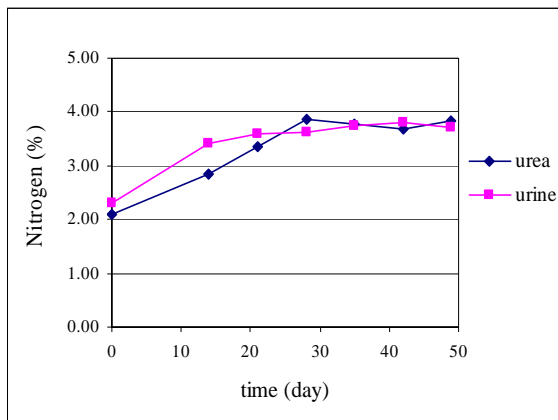


Figure 7. Total nitrogen content during composting

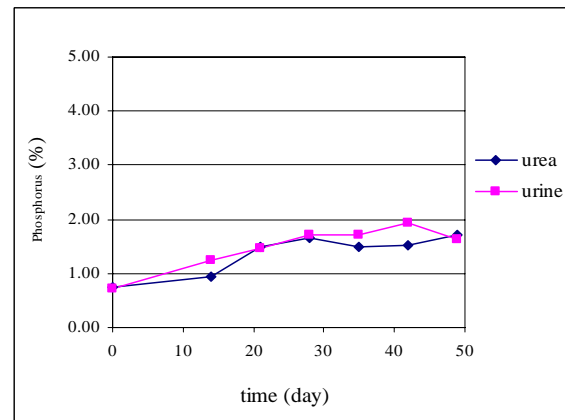


Figure 8. Phosphorus content during composting.

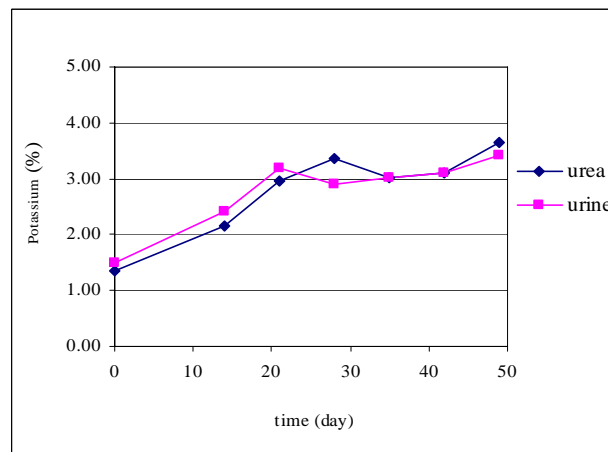


Figure 9. Potassium content during composting.

Figure 7 showed that the nitrogen of each composting materials adjusted with urea solution and urine increased from 2.09 % to 3.83 % and 2.30 % to 3.71 %, respectively along the process. The results showed that the trends of the nitrogen content in each composting materials adjusted with urea solution and urine were in the same and the final nitrogen content is not significantly different.

Phosphorus contents of each composting materials adjusted with urea solution and urine increased along the process from 0.75 % to 1.72 % and 0.71 % to 1.62 %, respectively as shown in Figure 8. The trends of the phosphorus contents in each composting materials were in the same. From the results showed that the phosphorous contents in the urine was not much affect to increase the phosphorous content in the composting material.

Potassium contents of each composting materials adjusted with urea solution and urine increased along the process from 1.36 % to 3.66 % and 1.48 % to 3.42 %, respectively as shown in Figure 9. The trends of the potassium contents in each composting

materials were in the same. From the results showed that the potassium content in the urine was also not affected to increase the potassium content in the composting material.

PLANT GROWTH TEST

This experiment would like to study affect of urine as nutrient source to plant growth. The parameters of plant growth tests which were fresh weight, height of stems, length of leaves, and width of leaves were studied as shown in Figure 10-13. This experiment was set into 3 treatments as followed:

- (1) Soil and water (S/W) as control
- (2) Soil and composted material with urea and watering with water (S+Cu/W)
- (3) Soil and composted material with urine and watering with water (S+Cu/W)

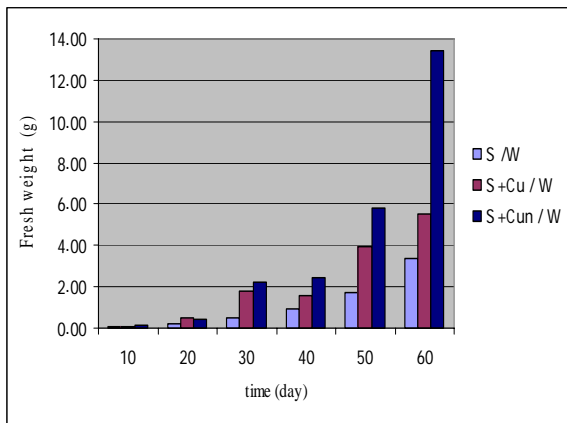


Figure 10. Fresh weight of Pakchoy.

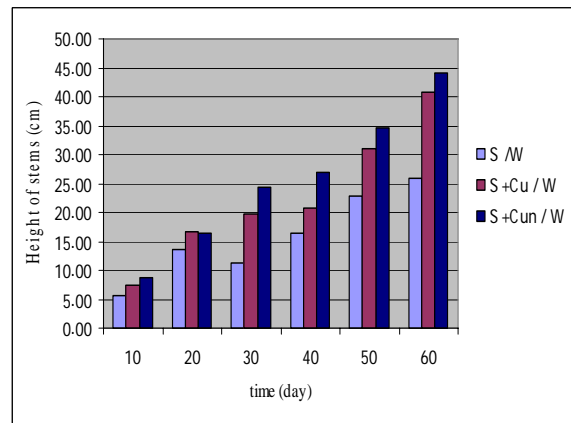


Figure 11. Height of stems of fresh Pakchoy.

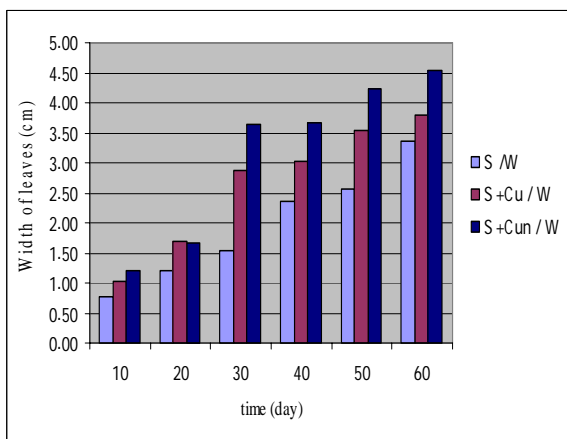


Figure 12. Width of leaves of fresh Pakchoy.

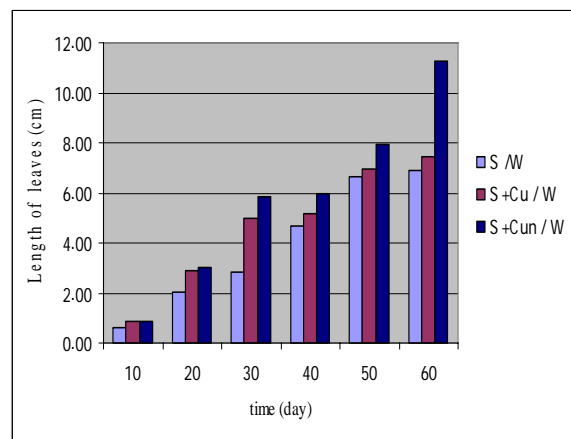


Figure 13. Length of leaves of fresh Pakchoy.

Figure 10 showed that the fresh weight of Pakchoy of 3 treatments increased throughout the experiment. In first ten days the fresh weight of Pakchoy of control, soil and



composted material with urea and soil and composted material with urine were not significantly at 0.070, 0.103, and 0.157 g., respectively. At the end of the experiment (60 days) the fresh weights of Pakchoy of control, soil and composted material adjusted water with urea and soil and composted material adjusted water with urine were significantly at 3.40, 5.55, and 13.42 g., respectively. The highest fresh weight of Pakchoy planted with soil and composted material with urine probably because the nitrogen in the urine was in a form readily available to plants [4]. Therefore, Pakchoy could use directly the nitrogen for its metabolism and growth.

Figure 11 showed that the height of stems of fresh Pakchoy of 3 treatments increased throughout the experiment. In first ten days the height of stems of fresh Pakchoy of control, soil and composted material with urea and soil and composted material with urine were at 5.77, 7.50, and 8.70 cm, respectively. At the end of the experiment (60 days) the height of stems of fresh Pakchoy of control, soil and composted material adjusted water with urea and soil and composted material adjusted water with urine were 25.90, 40.77, and 44.03 cm., respectively. The most height of stems of Pakchoy planted with soil and composted material with urine probably because the readily available nitrogen in the urine was directly used to plant growth and its metabolism [4].

Figure 12 showed that the width of leaves of fresh Pakchoy of 3 treatments increased throughout the experiment. In first ten days the width of leaves of fresh Pakchoy of control, soil and composted material with urea and soil and composted material with urine were at 5.77, 7.50, and 8.70 cm, respectively. At the end of the experiment (60 days) the width of leaves of fresh Pakchoy of control, soil and composted material adjusted water with urea and soil and composted material adjusted water with urine were at 25.90, 40.77, and 44.03 g., respectively. The widest leaves of Pakchoy planted with soil and composted material with urine probably because the nitrogen in form of readily available to plants used directly the nitrogen for its metabolism and growth [4].

Figure 13 showed that the length of leaves of fresh Pakchoy of 3 treatments increased throughout the experiment. In first ten days the length of leaves of fresh Pakchoy of control, soil and composted material with urea and soil and composted material with urine were not significantly at 0.60, 0.83, and 0.83 cm, respectively. At the end of the experiment (60 days) the length of leaves of fresh Pakchoy of soil and composted material adjusted water with urine was significantly at 11.27 cm. to control, and soil and composted material adjusted water with urea were at 6.87 and 7.43 cm, respectively. The longest leaves of Pakchoy planted with soil and composted material with urine probably because the readily available nitrogen in the urine was used directly for plant metabolism and its growth [4].

DISCUSSION AND CONCLUSIONS

The results of plant nutrients showed that nitrogen content of corncob and grass mixture adjusting water with urea solution was not significant to nitrogen content of corncob and grass mixture adjusting water with urine. Phosphorus and potassium content in urine was not affected to increase phosphorus and potassium content in composting materials (corncob and grass mixture).



The results of plant growth showed that Pakchoys planted in corn cob and grass mixture adjusting water with urine significantly grew much more than Pakchoys planted in corn cob and grass mixture adjusting water with urea in terms of the fresh weight and the length of leaves and grew more than Pakchoys planted in corn cob and grass mixture adjusting water with urea in terms of the width of leaves. The reason was probably because the nitrogen in urine was in a form readily available to plants. Therefore Pakchoys directly used the readily available nitrogen for their growth and metabolism [4]. While plant growth test in terms of the height of stems, Pakchoys planted in corn cob and grass mixture adjusting water with urine did not grow much more than Pakchoys planted in corn cob and grass mixture adjusting water with urea but grew more than Pakchoy planted in control. This reason was probably the nitrogen was not much affect to the height of stems.

In summary, the urine can be used instead of water (urea solution) for moisture content adjustment and also as nitrogen source for composting.

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