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Urban Organic Nutrients Harmless Treatment System

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Abstract: To solve the common problem of pet droppings in urban parks and improve the conflict caused by raising pets in the community, a pet droppings collection and disposal device was designed to be environmentally friendly and aesthetically pleasing. This device allows for protecting animal rights while turning waste into useful organic fertilizer that can used for community and park fertilization. This is not only good for plant growth but also can reduce the use of chemical fertilizers and reduce environmental pollution.

Keywords: Pet manure; Organic nutrients; Harmless treatment

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1. Introduction

With the development of the economy and the improvement of people's living standards, more and more families are keeping pets. According to the China Pet Consumption Report 2022, the number of dogs owned by urban residents alone reached 51.19 million in 2022 [1]. In real life, uncivilized dog-raising behavior is not uncommon. In daily life, the problems of pets defecating everywhere and not cleaning up pet feces in time are very common, and the conflicts between community residents and pets are becoming increasingly serious. Strengthening publicity and guidance as well as the disposal of animal feces can protect the rights and interests of animals and at the same time enable humans and pets to coexist harmoniously. This project studies the compost of pet manure, ferments animal manure into organic fertilizer, and thus carries out harmless treatment and forms a benign ecological cycle. At the same time, dog urine columns and animal-friendly signs are set up in parks and communities, and an environment-friendly and aesthetically pleasing pet feces collection and treatment device is designed and placed in the park, which is conducive to the collection and treatment of residents at any time.

Dog feces often contain parasites, such as tapeworms and roundworms. If this is not treated in time, it will cause environmental pollution and also affect human health. Hence, dog feces should be cleaned in time. Dog feces contain a variety of inorganic salts and organic matter, which can be treated and converted into organic fertilizer for community and park fertilization. This is not only conducive to plant growth but also can reduce the use of chemical fertilizers and reduce environmental pollution.

Manure needs to be decomposed and fermented before it can be used [2–3]. The fermented manure can improve the soil structure, contain more comprehensive nutrients, stable and lasting fertilizer effect, and contain rich humic acid, which can promote the formation of soil aggregate structure, improve soil moisture and air conditions, and make the soil soft and conducive to root growth. Manure not only contains a variety of large and medium micronutrients but also contains some substances that can stimulate root growth and a variety of beneficial soil microorganisms [4]. Pet droppings can be an effective source of manure [5]. However, collecting the manure can be a tricky problem. Much of the manure commonly found in parks loses organic matter after a while and can no longer be used for composting. To solve this problem, this study designed a device that initially ferments the manure once it has been collected [6]. This paper designs an experiment to verify the feasibility of fermentation experiments in small doses at high temperatures. In the literature review phase, this study found that most composting experiments are carried out on a large scale, at high temperatures, and under aerobic conditions. The facility was intended to operate in a small, anaerobic environment, so the study designed experiments to demonstrate that the facility could perform initial fermentation.

2. Facility preliminary design scheme

2.1. Park facilities design drawing

The overall design process is shown in **Figure 1**. A trash can is designed to collect the feces, which can automatically start the fermentation process after a certain amount of feces is put in, at the same time, it will close the entrance and send a collection signal to the person in charge, who will collect the feces and start the above process again.

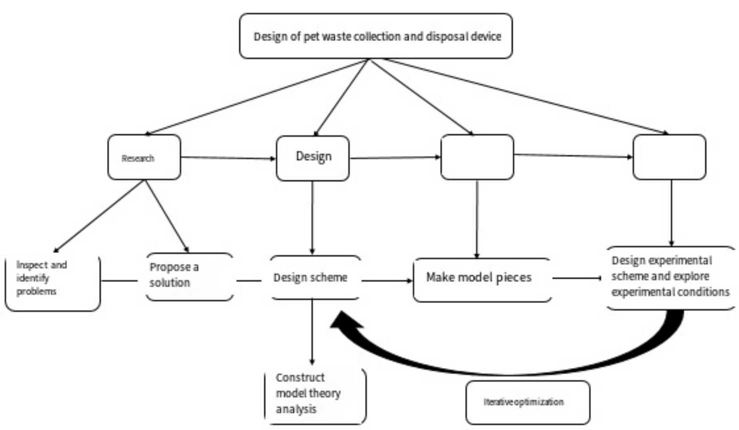

Figure 1. Design flow chart

The inside of the trash can is equipped with a fermentation material delivery device, stirrer, temperature, oxygen sensor, oxygen supply device, and fermentation bucket. The design sketch is shown in **Figure 2**. The outside of the trash can is set up with a feces pickup bag made of recycled waste paper so that people can directly throw the feces into the fermentation trash can after picking up the feces. The fermentation bin will undergo initial fermentation, and then the fermentation bucket will be sent to a place for centralized fermentation. After 20 days or so, the fertilizer will be taken out and the fermentation bucket will be put back into the trash can for recycling.

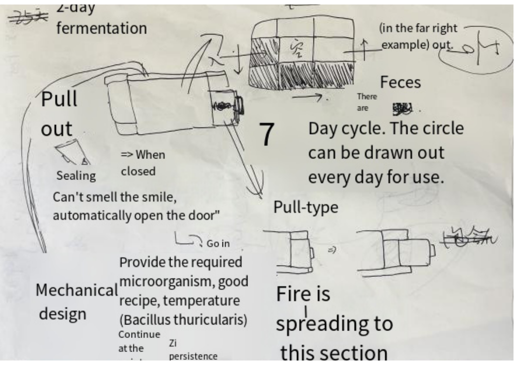

Figure 2. Design sketch

2.2. Park facilities fermentation process

(1) Add bran, straw, kitchen waste (a total of 5–10 kg), fermentation bacteria, and an appropriate amount of water.

(2) Stir well with a built-in mixer.

(3) Temperature: the starting temperature is controlled above 15°C, and the temperature is best controlled at 60–65°C during fermentation. Oxygen supplier + oxygen concentration sensor: 8–18%.

The exterior design drawing of the facility and the projection drawing are shown in **Figure 3** and **Figure 4.** The garbage can will be put into the community park and inside the community in a large range, and a certain number of management personnel will be equipped within a certain range to ensure the normal operation of the garbage can.

Figure 3. Exterior design drawings

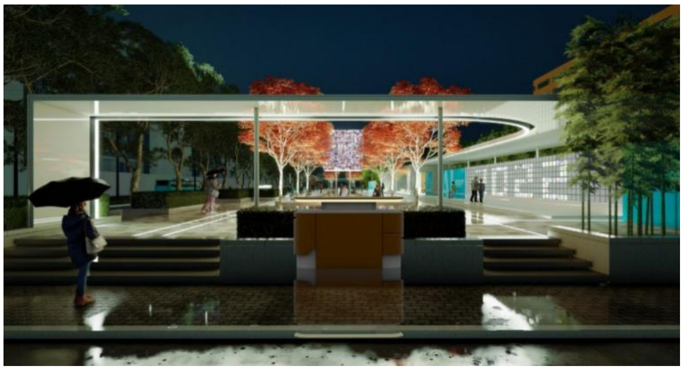

Figure 4. Schematic drawings

2.3. Explore the situation of small-scale fermentation at different temperatures

2.3.1. Experimental design

Experiment topic: Does small-scale fermentation produce different gases at different temperatures (36°C and 60°C)?

2.3.2. Operation process

Control group: fermentation at 36°C

Experimental group: fermentation at 60°C

Set three experimental groups and three control groups. The experimental material of each group was 80 g feces and 0.8 g effective microorganism (EM) strains in the medium with 2% *Aspergillus niger*, as this content obtained the best experimental results [7]. On this basis, because 80 g of water could not immerse all the materials, this study chose to use 100 g of water. The reason for the selection of EM strains is that the scale of this experiment is very small, and there is a chance of insufficient fermentation [8]. *Aspergillus niger* can make the material pile heat up quickly in large-scale fermentation, but in the experiment, the heating speed was not considered, so the EM strain was selected. EM strain contains more kinds of microbial flora, which can be propagated, fermented, deodorized, sterilized, and dried at the same time [9].

After adding all the bacteria, pour 100 g of water into the incubator and stir it thoroughly, then put it into the simulated experimental environment. Observe the fermentation every day. A sign of successful fermentation is the production of hydrogen sulfide and ammonia, which darkens the color.

3. Results and analysis

3.1. Experimental results

(1) At 60°C, experimental group A produced 4 tubes of 20 ml gas, experimental group B produced 3 tubes of 20 ml gas, and experimental group C gas was not collected.

(2) At 37°C, group A produced 1 tube of 20 ml gas, group B produced 2 tubes of >20 ml gas, and group C gas was not collected.

The gas composition content in the fermenter is shown in **Figure 5** and **Figure 6** below.

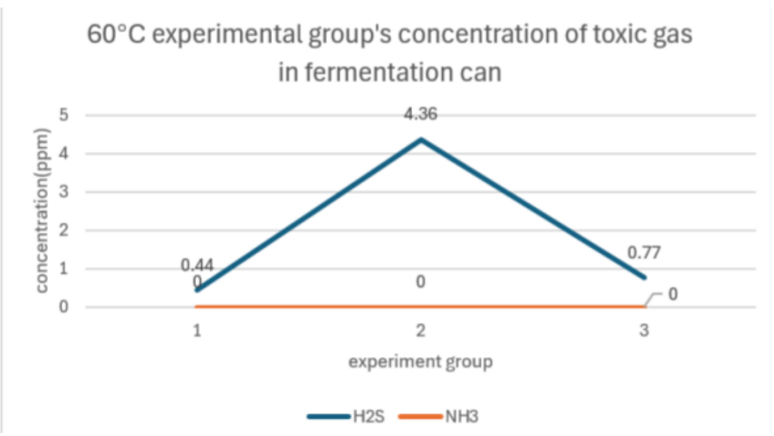

Figure 5. 60°C experimental group's concentration of toxic gas in fermentation can

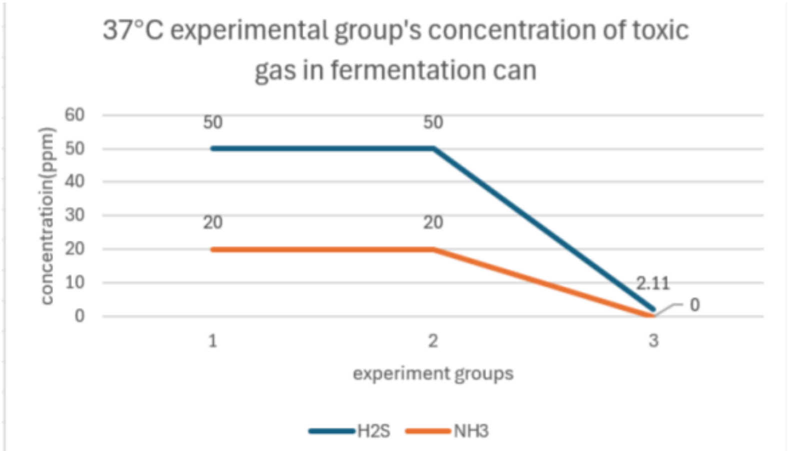

Figure 6. 37°C experimental group's concentration of toxic gas in fermentation can

3.2. Experimental conclusions

Under the experimental conditions set, both the high-temperature group and the normal-temperature group could produce fermentation, and extremely high H_2S and NH_3 contents were detected in the fermenters of both groups in the normal-temperature group. Based on the experimental results of anaerobic fermentation at 35°C and 25°C, the results were similar to those of the experimental group [10]. It can be further deduced that the higher the temperature, the higher the fermentation rate. In the composting process, NH3 is produced due to the ammonification of nitrogenous organic matter, and this process is most significant during the heating and high-temperature periods [11]. The H_2S generation is mainly due to the closed space in the composting group and the lack of contact between the material and the air, resulting in an anoxic environment that allows H_2S generation. It is believed that this is the result of different fermentation temperatures. Ammoniation of nitrogen-containing organic matter is accelerated at high temperatures, and the resulting gases are soluble in water. At low temperature, the experimental results show that the device produces a large amount of hydrogen sulfide and ammonia at 36°C, which proves that it is still in the incomplete fermentation stage at 36°C, and the fermentation period is long based on the gas production and color identification of fermentation (**Figure 7** and **Figure 8**).

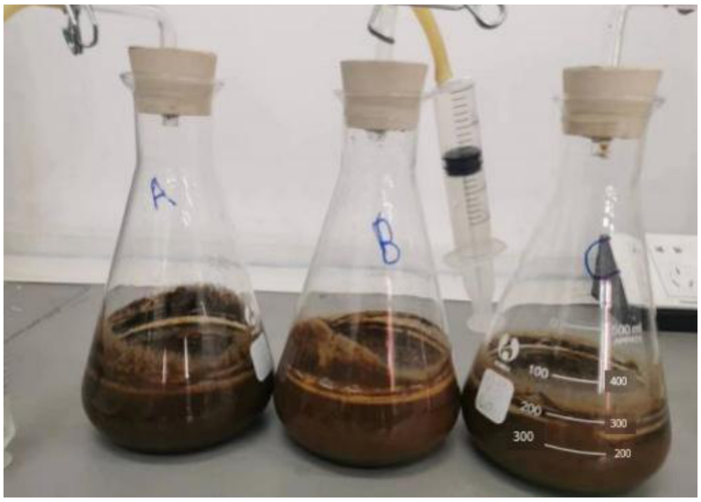
Figure 7. Color after fermentation of the experimental group at 60°C (greyish brown)

Figure 8. Color of the experimental group after fermentation at 37°C (yellowish brown)

4. Innovation and prospect

4.1. Innovation Points

Different from the medium experiment, this study chose to use EM compost bacteria for the experiment. EM compost bacteria contain more than 80 species from 10 different genera, each of which can provide its biota function [12–14]. As a single species of fungi, Aspergillus *niger* is unable to reduce the concentration of pathogenic microorganisms. At the same time, since the device requires a small amount of materials for preliminary fermentation, this study designed an experiment to determine whether there is a positive correlation between temperature and fermentation.

4.2. Outlook

Based on the experimental results, the study can conclude that high temperatures can promote the rate of small-scale fermentation. Due to the small scale, it is difficult for the temperature to reach 36°C or above in the middle stage of fermentation. The study chose to install a thermostat and solar panel in the device to maintain a high temperature while reducing energy consumption so that the fermentation can be continuously heated throughout the day in winter and at night in summer. Besides, apart from the temperature, the pH value is another factor that influences the result [15]. Hence, this could be an improvement of the experiment.

The plan is designed to pick up the scattered feces in the park and compost them in a centralized way, so small-scale anaerobic fermentation is adopted. However, this mode is easy to produce the above harmful gases, which is not conducive to the surrounding environment. In the future improvement of the device, the removal device of these gases can be added to facilitate the placement of them in the park.

Disclosure statement

The author declares no conflict of interest.

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