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Research on biological treatment scheme of two types of domestic waste in rural areas

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Abstract

With the rapid development of the economy and the progress of the times, my country's rural economy has developed rapidly, the economic effect has driven production and life, and people's consumption structure has also undergone tremendous changes, which also means that it brings more rural life. The amount of garbage and domestic garbage generated has gradually approached the urban level, and it is imminent to provide a better solution for rural garbage collection and treatment. When browsing online news, I noticed a news about raising cockroaches to feed on kitchen waste, and Flour weevil sucking plastic, so I have this paper, aiming to accurately grasp the specific principle of Tenebrio molitor's effect on plastic degradation through experiments, and to grasp The effectiveness of kitchen waste on cockroach breeding provides a more effective biological treatment solution for the two types of waste, improves the utilization rate of waste recycling, improves the living environment in rural areas, and improves the quality of life of the people. We hope that through our shallow research and investigation, we can bring new energy to rural garbage disposal!

Keywords

Flour weevil; cockroach; degradation; nutritional structure of kitchen waste .

1. Introduction

This paper mainly discusses the biological treatment of rural garbage by Flour weevil and cockroaches through experimental analysis. Experiment 1 firstly inspected the intestinal microflora of flour weevil to preliminarily judge that these plastics can be eaten, and then studied the optimal conditions for the mineralization of plastics. The polystyrene plastics labeled with α-13C were confirmed by the nuclear magnetic resonance spectrum of carbon 13 Which temperature and humidity are the best. In experiment 2, through the comparison experiment, change the feed ratio of kitchen waste to observe and record, and observe the activity and reproduction of cockroaches in the tank at the same time. Heavy metals, etc.) are mixed into the garbage to be treated, which will cause the cockroaches to reduce their mobility and even die. Finally, the purpose is to extract chitin in cockroaches raised by kitchen waste, and to determine whether the chitosan meets the industrial needs through purity identification.

2. Organization of the Text

2.1. Overview of experiments on white contamination by Flour weevil

2.1.1. Background

It is well known that plastics are difficult to degrade in the natural environment, among which polystyrene is the most difficult. Due to its high stability and high molecular weight, most of us think that microorganisms cannot degrade polystyrene plastics. In 2015, Professor Yang Jun's research group from Beihang University and Dr. Zhao from Shenzhen Huada published two sister research papers in the authoritative journal "Environmental Science & Technology" in

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the field of environmental science, which proved that Flour weevil (bread worms) can degrade the most refractory plastics such as polystyrene. This study shows that yellow meal larvae can survive on polystyrene as their sole food source for more than a month and develop into adults, which completely degrade the polystyrene they eat into carbon dioxide or assimilate it into their own fat , The plastic pollution problem that has become a global problem also has a new solution. Even so, try to minimize the use of plastic products in your daily life.

Today, people still believe that plastic products may not be decomposed in the environment for tens or even centuries due to their chemical and physical stability. According to some authoritative investigations, it is found that plastics such as polystyrene can only degrade less than 10% in some underground communities for several months. However, this polystyrene plastic waste accumulates about 40 million tons of plastic every year in the world, of which China accounts for 20%. Since 2005, Mr. Yang Jun began to study the biodegradation of plastics, mainly studying the degradation of refractory polystyrene plastics. Scientists first did research with some soil animals and found that they could not degrade this type of plastic. Therefore, we have to focus on other organisms, and also consider whether related genes can be isolated and extracted from some organisms. In the end, the team of scientists found in a 2014 study that yellow meal larvae can eat plastic so much that they can even use plastic as their only food. Flour weevil has the advantages of high survival rate, simple feeding, fast growth, and strong disease resistance. It can be further studied and found that Flour weevil can mineralize polystyrene plastic. (1)

2.1.2 Related experimental theories

What we need to know is that Floor weevil does not eat plastic, but it secretes digestive enzymes (special compound enzymes) that can digest foam plastic plates. This enzyme can open polymer bonds and benzene rings and destroy the molecular structure of organic molecules. So as to achieve plastic degradation. The principle of Tenebrio gnawing and degrading polystyrene is roughly as follows: First, the plastic foam is first chewed into small dense fragments by the Floor weevil and absorbed into its esophagus; The contact area between polystyrene and the microbes and digestive enzymes in the intestine of Floor weevil . The small foam fragments ingested are further degraded and repolymerized to form small molecular products under the catalysis of extracellular enzymes secreted by intestinal microbes; The small molecular fragments and the intermediate products produced by the degradation are mixed with some intestinal microorganisms, and are excreted in the form of feces, and the small molecular plastic products in the feces may further continue to degrade. (2)

2.1.3 Overview of the experimental process

Select appropriate experimental equipment and a number of Floor weevil with similar body shapes to conduct comprehensive experiments.

First of all, a preliminary judgment is made on whether the Floor weevil can eat such organic plastics. 1. In order to study the phenomenon that polystyrene plastics can be rapidly degraded and mineralized in the esophagus of Floor weevil , one kilogram of Floor weevil was purchased from a worm breeder and cultured in the laboratory for a week, and placed in squares of the same size. Metal box (accurately weighed), select an appropriate number of similar worms and put them in the box and weigh the total weight, then divide the Floor weevil into five groups and label them as ①②③④⑤. Put in plastic foam (pulverized) whose main component is polystyrene, and feed them with conventional wheat bran at the same time, and put them into five groups, and observe once every 12 hours; The activity intensity of meal worms should be weighed regularly. Considering the fact that adults of Floor weevil would kill each other, the insects that were bitten and died should be selected in time, and the weight data should be recorded. The total weight of the product, the reduction in the weight of the plastic foam. 3. Continue the experiment for one week, and finally process the data to obtain the net body weight gain of Floor weevil , and make a quantitative analysis. Floor weevil has limited mineralization of polystyrene, and Exiguobacterium tumefaciens YT2 (a community that can grow using polystyrene as the sole carbon source) was successfully isolated from the larval gut after the experiment.

Through the first experiment, it was found that Floor weevil would indeed swallow plastic foam by feeding; so the second experiment was carried out, taking the same amount of Floor weevil with the same life characteristics and dividing them into 10 groups, of which 5 groups were fed plastic foam , the other 5 groups were fed as normal, and the experimental results of the inspection of the intestinal microflora of Tenebrio larvae showed that the dominant intestinal flora was mainly Hafney, Morganella, and Escherichia coli. host. The colony numbers of Harbin and Morganella in the intestinal flora increased by 35.20% and 16.42%, respectively, compared with the conventional feeding group. This shows that Floor weevil and its esophageal microbes have a certain degrading effect on foam, and Harbella and Mormonella in its intestinal flora have the highest degradation efficiency on foam. evidence.

After proving that the flora in Floor weevil does have an effect on decomposing plastics, the next thing to consider is what and what conditions will affect the mineralization of Floor weevil on plastics, or what conditions will make Tenebrio mollusks decompose plastics What conditions can maximize the mineralization of Floor weevil in a factory environment. So for a third experiment, the meal worms were placed in a glass container filled with styrofoam blocks. Regularly measure the weight of the foam block (due to the change in mass before and after feeding by the Floor weevil). In the experiment, 500 Floor weevil took 5.8 grams of foam (pulverized) as the only food, and the temperature (25 degrees fluctuated by 10 degrees each time) 1° as the amplitude), humidity (20%~100% fluctuation, 5% as the amplitude) two conditions to control a single variable method (both of which are 16:8 light/dark cycle) in multiple groups in the greenhouse rearing. During the hatching process, Floor weevil that have stopped showing signs of life are removed immediately.

Taking temperature as an example, under the fixed conditions of 16:8 light/dark cycle and 20% humidity, each group of experiments is based on 15° with a range of 1°, and an appropriate number of insects with similar growth conditions are selected and placed in equal-weight boxes. Neutralize and weigh the total weight into five groups with temperatures ranging from 15° to 35°. In the results, during the 20-day experimental period, the larval mass was significantly increased (+33.6%) at a temperature of 25°, the residual foam was less, and the survival rate of larvae was higher compared to the other four groups. During the nearly 20-day experimental period, 37.7% of the foam they ingested was converted into carbon dioxide. The remainder (about 51.2%) was turned into excrement. Alpha-13C-labeled polystyrene plastic was used in the experiments to demonstrate that the carbon species were mineralized to carbon dioxide and lipids. The polystyrene foam in the larval esophagus was degraded within a residence time of less than 24 hours. Through the nuclear magnetic resonance spectroscopy of carbon 13 and thermal gravimetric Fourier transform infrared spectroscopy, the conclusion was confirmed that the polystyrene polymer molecules in the intestine were broken to form metabolites and excreted in the feces. The humidity experiment is the same. The 20-day experiment found that the nuclear magnetic resonance spectrum of carbon 13 and the thermal gravimetric Fourier transform infrared spectrum have the highest index when the humidity is 80%, that is, the mineralization effect on the foam is the greatest at this time. It has been proved by experiments that the temperature is 25° and the humidity is 80%. In the actual experiment, a smaller temperature and humidity range is actually used, but the data change range observed by the existing experimental instruments is not obvious. Substantial change.

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2.1.4 Practical application scheme

1. Propaganda: try to give speeches and publicity and mobilization about garbage classification in the countryside. In the stage of propaganda and launching, make full use of propaganda boards, etc., to increase efforts to publicize the purpose and significance of the classification and treatment of rural domestic waste.

2. Early adaptation: It is necessary to place trash cans marked with garbage classification in suitable locations in rural areas. Every household implements garbage classification and consciously conducts garbage classification to ensure garbage classification, collection, and transfer, without causing secondary pollution in the process. The process of domestic waste classification can be made into a chart. Compared with words, residents prefer to look at pictures. The charts are simple and clear, and will not cause ambiguity. In the stage of comprehensive centralized management, it is recommended to collect and reclassify all the garbage in the same area. The degradable garbage can be collected and stacked and fermented into farmyard manure; the non-degradable garbage can be divided into two types: recyclable and non-recyclable. The recyclable ones can be directly recycled, and the non-recyclable ones are sent to the garbage dump for centralized treatment, so as to have no adverse impact on the environment.

3. Establish a related operation mechanism: each household divides the garbage into recyclable and non-recyclable garbage, and puts them into their corresponding trash cans, and then the sanitation workers in each village will collect a piece and put it into the corresponding garbage dump, and at the same time maintain the village. The garbage collected in the garbage field is finally transported to specific occasions by the sanitation company for sorting and processing. Establish rules and regulations, and establish appropriate relevant mechanisms for each township and county based on the actual conditions of their respective regions. It is necessary to ensure the operation of garbage facilities in each village and the improvement of related systems.

4. Establish a garbage dump for plastic decomposition, and send all the recycled garbage to the plant for sorting and decomposition to achieve the purpose of degradation. At this time, Floor weevil is used, and the Floor weevil is applied to such factories, and the plastic waste is degraded. At the same time, the used Floor weevil in cycle saturation can also be used to produce Floor weevil dry feed, which is a perfect high-protein feed for some rare carnivores and any fish. The protein content of dried Floor weevil can be as high as 60%. , and is rich in amino acids. Can be used to feed some cats and fish and shrimp. Floor weevil with high protein has undergone a series of processing and is fed to animals, which can promote the normal development of these animals and improve disease resistance, so as to realize the diversified industry of garbage factories, make more full use of resources, and improve resources utilization. (3)

2.2. Overview of experiments on cockroach organic waste

2.2.1 Background

Cockroaches are a treasure of animals. Various active ingredients in cockroaches have been extracted and successfully developed medicines that can effectively treat heart failure, gastric bleeding, ulcers, and other diseases. German sickle is also used to develop cosmetics and daily chemical products, with anti-wrinkle and freckle-removing effects. Nowadays, aquaculture has spread all over our country, and scientific research on its potential value is also being carried out systematically.

The current treatment method of kitchen waste is to directly destroy landfill treatment and fertilizer treatment. Destructive direct discharge treatment is to directly crush and destroy the kitchen waste at the point where it occurs, and then use hydraulic flushing to discharge it into the sewer network, and then merge it with the urban sewage into the urban sewage treatment plant for centralized treatment. However, this method is not feasible in rural areas with immature sewers. Food waste in many parts of my country is sent to landfills together with general waste for landfill treatment. Because kitchen waste contains many degradable components, and the stability of these substances is short, it is more difficult to utilize organic waste such as kitchen waste. Waste disposal sites are efficient and can produce huge ecological benefits.

Therefore, the use of cockroach-based organisms to treat kitchen waste with organic matter as the main component not only has huge ecological benefits, but also contains potential economic benefits.

2.2.2 Related experimental theories

By raising cockroaches to explore whether they can carry out normal life activities in the environment of kitchen waste, and then applying cockroaches to the problem of garbage disposal, it is necessary to consider the impact of other garbage in the domestic garbage on the breeding of cockroaches. The purpose of this paper is to give cockroaches different feeds (based on kitchen waste) through a control variable comparison experiment to prove whether kitchen waste can keep cockroaches in a normal state of survival and reproduction. Harmful domestic waste (such as foam plastic, electronic waste, heavy metals, etc.) mixed into the waste to be treated will reduce the activity of cockroaches, or even die, thus affecting the efficiency of the experiment. By consulting the information, it is found that chitin (the second largest natural polymer) is contained in the epidermis of arthropods (cockroaches), so on the basis of the above test experiments, a new cockroach treatment industrial line is designed for actual industrial production. , then it is necessary to explore whether the chitin produced by cockroaches raised with kitchen waste can meet the needs of industrial production.

Specific experiments: Experiment 1: Set up three groups of equal feeding, in which the first group is normal kitchen waste, and the second group adds plastic powder, glass and ceramic mixed powder, corn cob powder, etc. on the basis of the first group The third group added common metals, heavy metals and other industrial product waste mixed powders on the basis of the second group, cultivated in the culture tank, observed and recorded every day, and observed the activity and reproduction of cockroaches in the tank. Experiment 2: According to the literature, we know that the chitosan concentration of the deacetylation degree required by the industry needs to be higher than 70%. When checking the change of the chitin content in the above-mentioned experimental cockroaches, it was planned to adopt the acid-base method to extract the chitin inside the worm body, and then the chitin that was extracted was placed under NaOH conditions (temperature controlled at 130 ° C), the reaction 3h, the deacetylated chitosan was obtained. Then, the purity of chitosan is identified to determine whether it meets the industrial needs.

2.2.3 Research on feeding experiments

1. Materials and methods

1. Test insect German sickle

2. Breeding conditions: temperature (26 ± 2) ℃; humidity (60 ± 10) %.

3. Utensils and materials

3.1. Rearing tank: round or square. For round shape, the diameter should not be less than 20 cm and the height should not be less than 30 cm; for square shape, it should not be < 30 cm × 30 cm × 30 cm.

3.2. Cockroach grills: the spacing is 1 to 2 cm.

3.3. Separation cylinder: It should be round, and the bottom should be covered with a 12-mesh sieve, and the diameter should be smaller than the diameter of the round cylinder or the width of the square cylinder.

3.4. Petri dish: 6 to 9 cm in diameter.

3.5. Others: paraffin oil, petrolatum, sponge, three feeds that simulate kitchen waste under different conditions (No. 1 feed: 88% corn, rice and wheat mixed meal, 0.5% salt, 0.5% toilet paper powder, dried meat and fish Class mixed powder 5.5%, dried animal bone mixed powder 1%, vegetable oil 1%, animal oil 1%, edible sugar 2%, sawdust powder 0.5%;

Feed No. 2: corn, rice and wheat mixed meal 83.5%, salt 0.5%, toilet paper powder 0.5%, dried meat and fish mixed powder 5.5%, dried animal bone mixed powder 2%, vegetable oil 1%, animal-based Oil 1%, edible sugar 2%, sawdust powder 0.5%, plastic powder 1.5%, glass and ceramic mixed powder 1%, corn cob powder 1%, straw powder 1%;

Feed No. 3: 80.5% corn, rice and wheat mixed meal, 0.5% salt, 0.5% toilet paper powder, 5% dried meat and fish mixed powder, 2% dried animal bone mixed powder, 1% vegetable oil, 1% animal fat, 2% edible sugar, 0.5% sawdust powder, 1.5% plastic powder, 1% glass and ceramic mixed powder, 1% corn cob powder, 1% straw powder, yeast powder, edible alkali and various flavors 1% of the mixture of common metals and heavy metals and other industrial product waste mixed powder 0.5%, crushed cloth powder 0.5%, cotton wool 0.5%.) , beaker 50 ~ 150ml.

4. Breeding technology: Apply a 3-5 cm wide oil strip (paraffin oil: Vaseline 1:1) in the mouth of the separation tank, and build 2 petri dishes, 1 for mouse feed and 1 for water sponge. The separation tank was placed in the center of the rearing tank with a cockroach grid at the bottom, and 30 to 50 females with brown egg sheaths were moved into the separation tank, observed and recorded every day. After the female worms shake off the egg sheath and hatch the nymphs for 1 day, take out the feed and water dish in the separation tank, shake the separation tank, wait for the nymphs to shake into the rearing tank, move the egg-laying adults to the passage tank, and record the separation date. Clean separation tank and utensils. In the rearing tank, 2 petri dishes were placed on the cockroach grid.

1 contained simulated feed and 1 contained water sponge, and the water sponge and supplementary feed were replaced every 2d. For water feeding, a beaker full of water can also be used upside down in a petri dish. After the water is exhausted, the vessel can be cleaned and replaced with water.

5. Evaluation index: The body weight parameters of 10-day-old adults were used as the evaluation index of breeding technology. (3)

2. Experimental results

The body weight indexes were measured by repeating batches of No.

where X is the intermediate value S is the float value

Table 1: shows the results of body weight measurement of German sickle fed with feed No. 1

batch	weight	
	(X±S) /♀	(X±S) /♂
1	105.8±7.6	54.3 ± 3.4
2	96.8 ± 8.7	48.5 ± 4.5
3	98.7 ± 8.9	47.2 ± 4. 3
Remark	normal biological activity	

Table 2: shows the results of the body weight measurement of the German sickle raised with feed
No. 2

batch	weight

	(X±S) /♀	(X±S) /♂
1	97.6±7.6	44.9 ± 3.4
2	85.4 ± 8.7	41.2 ± 4.5
3	90.7 ± 8.9	39.6 ± 4. 3
Remark	Reduced activity of cockroaches, guessed to be the reason for the addition of plastic and more plant fiber powder	

Table 3: shows the results of the body weight measurement of German sickles raised with feed No. 3

batch	weight	
	(X±S) /♀	(X±S) /♂
1	87.4±5.6	43.1 ± 2.9
2	/	/
3	91.7 ± 2.1	/
Remark	The experimental organisms died on a large scale, and the surviving individuals also showed a significant decrease in activity. Harmful powder (such as heavy metal powder, plastic powder) was the main reason for the death of experimental organisms	

The above results showed that the body weight reproducibility of 9 batches of German cockroaches was good in standardized breeding, which indicated that the standardized breeding method was feasible. At the same time, it is shown that if some of the toxic and harmful domestic wastes (such as foam plastics, electronic waste, heavy metals, etc.) are mixed into the garbage to be treated, the activity of cockroaches will be reduced, and even death will be caused. Therefore, if the principle of cockroaches processing kitchen waste is put into industrial production, the economic efficiency will be reduced due to the careful classification of waste to prevent the mixing of toxic and harmful waste.

2.2.4 Experimental investigation of chitin

Quantitative analysis of chitin in cockroaches

1) Dry the adult worm body, call its weight and record it as Q1

2) The chitin extracted by acid-base method will be weighed after drying and recorded as Q2

3) The calculation method of cockroach chitin content is chitin content=Q2/Q1×100%

According to the acid-base method, in the above-mentioned cockroach breeding experiment, the chitin yield of the dried cockroaches cultivated with feed No. 1 is stable at about 14.6%, and the extraction rate of chitin from the dried cockroaches cultivated with feed No. 2 can also be It is stable at about 13.4%. At the same time, we also measured the extraction rate of chitin for all individuals who survived to the end of the experiment on No. 3 feed. It contains harmful ingredients and needs to be rinsed with distilled water several times, and special treatment is required if necessary). We then converted chitin into deacetylated chitosan using the method described above. After the content determination, they were 81%, 78%, and 75%. By measuring its content is higher than 70%, can be used for industrial production.

To sum up, we believe that the chitin content in the cockroaches raised by the three kinds of feeds is not too different, and they can all be used for industrial production after a specific process. That is, chitin extracted from cockroaches cultivated with rural kitchen waste under normal conditions can be used in industry.

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Attachment: Calculation of the degree of deacetylation: acid-base titration

Accurately weigh the chitosan pond sample with an electronic balance. 59, placed in a 250mL conical flask, and added 0. 1 mol/L standard hydrochloric acid was continuously stirred at room temperature of 20±5°C until it was completely dissolved. Then add 2 drops of methyl orange indicator. Use 0. 1mol/I. Titrate excess hydrochloric acid with standard sodium hydroxide solution until the solution turns yellow. Another sample was dried at 105°C to constant weight, and the moisture content was determined. Each sample was measured 3 times. Calculate the degree of deacetylation by the following formula. Theoretical amino mass fraction:

$$16/161\times 100\%=9.94\%$$

$$\omega_1=(c_1v_1-c_2v_2)\times 0.016 \div g \times (100-\omega)\times 100\% \times \omega_1$$

$$\omega_2=\omega_1 \div 9.94\% \times 100\%$$

Note:

ω_1-represents the concentration of the amino group

ω_2-represents the concentration of the free amino group

c_1,v_1-respectively represent the concentration (mol/L) and volume (L) of hydrochloric acid

c_2, v_2-respectively represent the concentration of sodium hydroxide (mol/L) and the volume consumed (L)

g -means sample (g)

ω- represents the water content in the sample (%)

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