THE EFFECT OF APPLICATION OF SULFUR DOSAGE VARIATIONS ON *BAITING GEL* ON IMAGO MORTALITY *Periplaneta americana* YEAR 2021

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Abstract

Introduction A vector is an arthropod animal that has the role of transmitting, transferring, and being a source of disease transmission. Cockroaches are mechanical vectors for several pathogenic microorganisms. Vector control is necessary to prevent the transmission of vector-borne diseases. Widely used chemical controls such as spraying and fumigation can create harmful residues for humans and the environment. A safer and more effective method is needed, namely using the b*aiting gel* method for cockroach control. The research of Gani Bakhtiar (2020) shows that the application of 1 gram of sulfur has a killing power effect of only 5%. The purpose of this study was to analyze the effect of the application of various sulfur dosages in *baiting gel* on mortality of imago *Periplaneta americana*. **This type of research** is a quasi-experimental study with a non-equivalent control group design. The research was conducted by controlling the *baiting gel* without using sulfur and the treatment was given the application of baiting gel which was given sulfur as a poison. Each cage contains 5 *Periplaneta americana* and the application was carried out for 3 days with 4 replications. **The results** showed that a dose of 1 gram of sulfur had a killing power of 0%, a dose of 3 grams of sulfur had a killing power of 0% and a dose of 6 grams of sulfur had a killing power of 0%. There was no effective dose of sulfur to kill *Periplaneta americana*. All the data obtained have a value of 0 and the data is homogeneous so that it cannot be analyzed by statistical programs. **This study concludes** that there is no effect of the application of various sulfur dosages in *baiting gel* on the mortality of *Periplaneta americana* imago.

Keywords: *Periplaneta americana*; cockroach; *baiting gel*; mortality; sulfur.

A. Introduction

A vector is an animal that is an arthropod phylum that has the role of transmitting, transferring, and being a source of disease transmission (Republic of Indonesia Minister of Health Decree No. 50, 2017). Disease vectors are arthropods that act as transmitters of the disease so that they are called arthropod-borne disease or vector-borne disease, which is one of the endemic diseases and can pose a danger to human health until death. (Republic of Indonesia Minister of Health Decree No. 50, 2017).

Cockroaches can spread various disease pathogens. Several types of cockroaches are often found in residential areas such as American cockroaches (*Periplaneta americana*), German cockroaches (*Blatella germanica*), and Australian cockroaches (*Periplaneta australasiae*).

Periplaneta americana becomes one of the most dangerous types of cockroaches because it has behavior of eating food and dirt and then regurgitating some of the food that has been digested. Cockroaches are mechanical vectors of several microorganisms such as *Streptococcus sp, Salmonella sp, Pseudomonas aeruginosa, Mycobacterium sp, Shigella sp, Campylobacter sp, Klebsiella pneumonia.* Cockroach bodies have a total plate count (ALT) of 3.7 x 106 colonies/gr and as much as 3.3% of domestic cockroaches have been contaminated with *Salmonella enteritidis* (Dwi et al., 2017)

Cockroach control can be done in several ways, such as sanitary, biological, mechanical, and chemical. Chemical methods that are widely used by society can cause residues that are harmful to humans (*EHW*, 2005). Therefore, it is necessary to do another method that is safer and more effective, namely by using the *baiting gel* method as an alternative in cockroach control.

Control with the *baiting gel* method is considered to be one of the safest methods for humans and the environment because this baiting control will only hit the target animal through the oral route (Potter, 2015). *Baiting gel* is bait in the form of a combination of several chemical compounds used to attract cockroaches to come and eat the bait, after eating the bait the cockroaches will die from eating bait containing insecticides.(Arifah et al., 2016).

The results of Salbiah's (2007) study show that American cockroaches prefer foods that are high in protein and have a pungent smell like

peanut butter. (Salbiah, 2007). The results of research by Herma Amalia and Idham Sakti Harahap (2010) show that the combination of strawberry-egg jam bait is quite effective in attracting cockroaches because some cockroaches enter the trap and consume the bait provided (Amalia & Harahap, 2015).

Baiting gel includes stomach poison. Stomach poison is a poison that works after food enters the insect's stomach. The poisonous bait widely used today is chronic or doesn't kill cockroaches too quickly. The greater the percentage of feed consumption, greater and faster mortality is expected in controlling the pest population(Arifah et al., 2016).

Sulfur has been found since 1,000 years before Christ, so it is said to be the oldest pesticide ingredient. Sulfur pesticides are potassium polysulfides that are composed of calcium oxide and sulfur. Potassium polysulfide compounds have been shown to be effective against pests such as mites and are often called lime sulfur. *Lethal Dose Sulfur* per oral has a fairly large dose of 50,000 ppm (mg / kg body weight), sulfur has a characteristic and pungent odor so it can have a dehydrating effect on cockroaches which make the crust dry (Firdaust & Purnomo, 2019). Natural sulfur pesticides have been tested for their effectiveness on the mortality of Polyphagotarsonemus latus with a single dose of 0.5% sulfur which can cause 79.47% mortality, while at higher concentrations (1.0-2.5%) it causes 90-97% mortality (Balitbang, 2011).

From the description above, the researcher is interested in conducting research entitled "The Effect of Application of Sulfur Dosage Variations in *Baiting gel* on Mortality of Imago *Periplaneta americana*".

B. Material and Methode

This type of research is quasi-experimental research (quasi-experimental) with a non-equivalent control group design. The independent variable in this study was the sulfur dose in the *baiting gel* of 1 gram of sulfur, 3 grams of sulfur and 6 grams of sulfur. The dependent variable in this study was the mortality of *Periplaneta americana*. The control variables in this study were cockroach stage, cockroach size, time of observation as well as the type of cockroach. Confounding variables in this study were temperature, humidity, lighting, contamination of microorganisms in *baiting gel*.

The research object was *Periplaneta americana* which was taken from a resident's house. Experiments were given treatment A (sulfur 0 grams) as control, treatment B (sulfur 1 gram), treatment C (sulfur 3 grams), and treatment D (sulfur 6 grams). With each sample containing 5 cockroaches.

The *baiting gel* was made by mixing ingredients such as peanut butter weighing 50 grams, strawberry jam weighing 20 grams, and egg whites weighing 30 grams which were measured using a scale. Mix the *baiting gel* ingredients until they are evenly mixed and smooth, then mix the *baiting gel* with the active sulfur ingredients that have been mashed according to their respective dosages (1 gram of sulfur, 3 grams of sulfur, and 6 grams of sulfur) using a mortar and spatula. To facilitate application, the *baiting gel* was put into a syringe with a size of 25 ccs. Each *baiting gel* application plate was filled with a weight of 20 grams per treatment. The treatment for each sample was carried out 4 times, by preparing 5 *Periplaneta americana* in each experiment so that the total sample needed was 80 cockroaches.

Researchers used a cockroach cage with a cage area specification of 40 x 40 cm2. Researchers used a syringe to facilitate the application of *baiting gel*. Researchers conducted observations every 12 hours to see cockroach mortality, such as behavior and physical changes in cockroaches. In addition, researchers also measured temperature, humidity and lighting in the research room. The study was conducted for 3 days, each replication the researcher weighed the *baiting gel* before consumption and after consumption.

Analysis of the data used in this study using the ANOVA test. The hypothesis used in this study is that there is an effect of the application of various sulfur dosages in *baiting gel* on the mortality of *Periplaneta americana* imago.

C. Results and Discussion

1. Take *Baiting gel Periplaneta americana*

The control with the 1st replication had the amount of *baiting gel* consumption with a weight of 2 grams, the 2nd replication had the amount of *baiting gel* consumption with a weight of 4 grams, the 3rd replication had the amount of *baiting gel* consumption with a weight of 3 grams, the 4th replication had the amount of consumption of *baiting gel* weighing 4 grams

At the dose of 1 gram of sulfur as treatment 1 with the 1st replication has the number of consumption of *baiting gel* with a weight of 2 grams, the second replication has the number of consumption of *baiting gel* with a weight of 3 grams, the 3rd replication has the number of consumption of *baiting gel* with a weight of 2 gram, the 4th replication has a consumption of *baiting gel* weighing 1 gram.

At a dose of 3 grams of sulfur as treatment 2 with the 1st replication has the amount of *baiting gel* consumption with a weight of 3 grams, the 2nd replication has the amount of *baiting gel* consumption with a weight of 2 grams, the 3rd replication has the amount of *baiting gel* consumption with a weight of 2 grams , the 4th replication has a consumption of *baiting gel* with a weight of 3 grams.

At a dose of 6 grams of sulfur as treatment 3 with the 1st replication has the amount of *baiting gel* consumption with a weight of 2 grams, the 2nd replication has the amount of *baiting gel* consumption with a weight of 3 grams, the 3rd replication has the amount of *baiting gel* consumption with a weight of 2 grams, the 4th replication has a consumption of *baiting gel* with a weight of 2 grams.

The results of the overall consumption of *baiting gel* for 3 days by *Periplaneta americana*, after the test, obtained the consumption of *baiting gel* in replications 1 to 4 with a dose of 0 grams of sulfur with a weight of 67 grams, a dose of 1 gram of sulfur with a weight of 72 grams, a dose of 3 grams of sulfur with a weight of 70 grams and a dose of 6 grams of sulfur with a weight of 72 grams.

The cumulative results of consumption of *baiting gel* for 3 days by *Periplaneta americana* after being tested, obtained the cumulative results of consumption of *baiting gel* on replication 1 to 4 with a dose of 0 grams of sulfur with a weight of 13 grams, a dose of 1 gram of sulfur with a weight of 8 grams, a dose of 3 grams of sulfur with weight 10 grams and a dose of 6 grams of sulfur with a weight of 9 grams.

The results of the average consumption of *baiting gel* for 3 days by *Periplaneta americana* after the test showed that the average consumption of *baiting gel* in replication 1 to 4 with a dose of 0 grams of sulfur with a weight of 3.25 grams, a dose of 1 gram of sulfur with a weight of 2 grams, a dose of 3 grams of sulfur with a weight of 2.5 grams and a dose of 6 grams of sulfur with a weight of 2.25 grams.

Based on the research results of Gani Bakhtiar (2020), it shows that the application of 1 gram of sulfur has a killing power effect of only 5%(Rifai, 2020). Whereas in this study, the researchers used sulfur doses of 1 gram, 3 grams, and 6 grams, each of which did not have a killing effect or 0%. One possibility of the sulfur dosage has no killing power, because the dose of sulfur used is too large to make cockroaches less fond of *baiting gel* so that cockroaches only consume a small amount of *baiting gel* at each given dose.

Periplaneta americana has a very sharp sense of smell because it has almost twice as many olfactory receptors as other insects. These numerous olfactory receptors help *Periplaneta americana* to more easily detect traces or odors of food, especially in fermented foods that cockroaches prefer. So it can be concluded that the dosage used in this study is too large so that the cockroaches consume only a small amount of *baiting gel* containing sulfur. According to Subiyakto (2011), a pesticide is categorized as effective if it causes mortality of more than 80% of the tested insects, while treatments that use sulfur only have a mortality rate of 60% because the sulfur content in sulfur has not been effective in controlling insects (Subiyakto, 2011).

In the study of Gani Bakhtiar (2020), the researchers satisfied the cockroaches for 3 days so that the weight of the *baiting gel* could be reduced more by around 4 - 8 grams (Rifai, 2020). In this study, researchers only satisfied the cockroaches for 1 x 24 hours with the weight of the *baiting gel* consumed by only 2 - 4 grams, this happened because the cockroaches were not too hungry in consuming *baiting gel*. Therefore, it can be concluded that in satisfying cockroaches, it must be more than 1 x 24 hours or 1 day so that when the cockroaches enter the experimental drum, they can be satisfied with the *baiting gel* bait that has been provided.

In addition to satisfying cockroaches for longer, cockroach conditioning is also needed well in advance of the day before, when researchers raised cockroaches did not get used to giving *baiting gel* bait, when researchers had not gotten used to feeding *baiting gel* containing peanut butter, eggs, and strawberry jam. Researchers only provide cabbage every day. Cockroaches usually consume *baiting gel* without chemicals, this can make cockroaches consume more *baiting gel* at the time of the experiment so that it can cause mortality in cockroaches.

Food spoilage can occur due to factors of temperature, humidity, light, time, and factors of microorganisms such as bacteria, fungi, protozoa, and others (Hadiyanto, 2013). During the study, researchers observed the *baiting gel* on *Periplaneta americana* for 3 days, from 3 days there were microorganisms in the *baiting gel* in the form of fungi, causing the *baiting gel* to be contaminated. With the contamination from these microorganisms, *Periplaneta americana* is not interested in consuming *baiting gel*.

In a previous study conducted by Gani Bakhtiar (2020), researchers allowed the results of consuming *baiting gel* for 10 days after the study, the researchers found that *baiting gel* in treatment 4 or a dose of 1 gram of sulfur was already contaminated with microorganisms such as fungi, while in treatment 2 and 3 mixed with borax, the researchers found no visible microorganism contamination with the senses. Therefore, it can be concluded that *baiting gel* with borax compounds can preserve cockroach food because it prevents microorganisms that cause decay. With the prevention of decay from microorganisms, *Periplaneta americana* prefers to consume *baiting gel* given by researchers (Rifai, 2020).

Based on research conducted by Gani Bakhtiar (2020) using a combination of sulfur and borax, researchers say that borax has thickening properties and a longer resistance than *baiting gel* that is not given borax (Rifai, 2020). The long durability is due to the borax content in the *baiting gel* which can prevent fungi, bacteria, and yeast so that the *baiting gel* food can last longer.

Based on the above statement, it can be concluded that the *baiting gel*, whose active ingredient is a combination of borax and sulfur, is preferred by cockroaches because of the dominant role of borax in providing a chewy texture so that imago cockroaches are attracted to consuming *baiting gel*. In addition, the addition of borax can also inhibit microbial activity so that it can preserve *baiting gel* bait.

2. *Periplaneta americana* mortality rate

Periplaneta americana mortality rate is one of the tests used to determine whether the *baiting gel* application can be used as a cockroach control or not. Age and condition of cockroaches are factors that can support cockroach mortality from *baiting gel* application. Therefore, we need to know the phase and condition of the cockroach according to the *baiting gel* application we are using. The cockroach phase we will use is the imago phase because it matches the texture of the *baiting gel* that we will use, which tends to be solid like a paste. American cockroach nymphs prefer liquid and soft-textured bait, while imago prefers solid bait with high water, sugar, and protein content.(Amalia & Harahap, 2015). Based on this research, it can be said that the imago phase is an appropriate phase to support cockroach mortality with the application of *baiting gel*, because in this imago phase cockroaches like solid foods with high water, sugar and protein content according to the texture and content in the *baiting gel*.

In addition to the cockroach phase, cockroach conditions also affect cockroach mortality with the application of *baiting gel*, with good and healthy cockroach conditions, it is hoped that cockroaches will be more eager to consume *baiting gel*, apart from being in good and healthy condition, the researchers also satisfied *Periplaneta americana* for 1 time 24 hours before doing the experimenting using *baiting gel*, by fasting for 1 x 24 hours it is hoped that when doing the experiment cockroaches can be more eager to consume *baiting gel* so that the probability of mortality will be higher.

Imago *Periplaneta americana* is declared dead if the cockroach is unable to move its body and the cockroach's body position is upside down or in the ventral position the cockroach is unable to move its body back. Cockroach mortality can be caused by consuming *baiting gel* which contains chemical toxins so that it can be toxic to *Periplaneta americana*.

As the results of the study shown At a dose of 1 gram of sulfur as treatment 1 with replication 1 to 4, no *Periplaneta americana* died at that dose. At a dose of 3 grams of sulfur as treatment 2 with replication 1 to 4, no *Periplaneta americana* died at that dose. At a dose of 6 grams of sulfur as treatment 3 with replication 1 to 4, no *Periplaneta americana* died at that dose.

The mean mortality of *Periplaneta americana* after being tested using *baiting gel* showed that the mean mortality of *Periplaneta americana* on replication 1 to 4 obtained a dose of 1 gram of sulfur at 0%, 3 grams of sulfur at 0%, and 6 grams of sulfur at 0%. The results of observing the treatment dose of 1 gram of sulfur, 3 grams of sulfur, and 6 grams of sulfur and the analysis of each poison can be seen from the following discussion:

a. A dose of 1 gram of sulfur

A a dose of 1 gram of sulfur, the first day of observations there was no mortality in all four replications. Observation of the first and second 12 hours shows that there is no mortality in *Periplaneta americana*, this shows that *baiting gel* is a chronic poison so that mortality in *Periplaneta americana* is not fast. However, in the third and fourth 12 hours, *Periplaneta americana* had started consuming *baiting gel*, *Periplaneta americana* was interested in consuming it because the content of the *baiting gel* used was following her favorite food. At the fifth and sixth hours, *Periplaneta americana* no longer consumed *baiting gel*.

b. A dose of 3 grams of sulfur

A a dose of 3 grams of sulfur, observation on the first day of the fourth day of replication did not cause mortality. In the first and second 12 hours of observation, it was shown that there was no mortality in *Periplaneta americana*. At the third and fourth 12 hours, *Periplaneta americana* consumed sulfur with devouring compared to the previous dose but there was no sign of mortality in *Periplaneta americana*. At 12

hours five and six cockroaches were still consuming *baiting gel* even though they had not eaten the day before and did not cause mortality in *Periplaneta americana*.

c. A dose of 6 grams of sulfur

A a dose of 6 grams of sulfur is the largest dose of the dose used by previous researchers. On the first day, the first 12 hours and the second, the cockroaches were faster in approaching the bait, but there was no mortality in *Periplaneta americana*. On the second day, 12 hours three and four there were still no signs of mortality that occurred in *Periplaneta americana*. On the third day, 12 hours, the fifth and sixth, there was no mortality that occurred, the same as the previous days.

3. Analysis of the effect of variations in sulfur dose on mortality of *Periplaneta americana*

The effect of *baiting gel* dosage variation on mortality of *Periplaneta americana* used statistical calculations. The statistical test was used to determine whether or not there was a difference in the number of mortality of *Periplaneta americana* at each variation of the sulfur dose applied to the *baiting gel*. However, after the researchers conducted the experiment, it was found that there were no cockroaches that died. Then, after doing data entry in the statistical program, because all data is worth 0 and the data is homogeneous so that it cannot be analyzed statistically (Santjaka, 2011).

Sulfur dosage can be categorized as ineffective, this can be seen by looking at the average mortality in each treatment. As the average mortality of *Periplaneta americana* in the application of 1 gram of sulfur is (0%), the average mortality of *Periplaneta americana* in the application of 3 grams of sulfur is (0%), the average mortality of *Periplaneta americana* in 1 gram sulfur dose application was (0%). So it can be seen that the three doses are not yet effective in killing *Periplaneta americana*. The sulfur dosage has not been said to be effective because it cannot kill more than 80% of the tested insects.

Imago *Periplaneta americana* is declared dead if the cockroach is unable to move its body and the cockroach's body position is upside down or in the ventral position the cockroach is unable to move its body back. Cockroach mortality was due to the sulfur content which is a chemical poison, so it can be toxic to *Periplaneta americana* even though the toxicity is low for humans and mammals.

The LD-50 (lethal dose) value of oral sulfur is quite large, namely 50,000 ppm (mg / kg body weight) which indicates that sulfur is a relatively safe pesticide. The pungent sulfur odor can be removed by the pungent smell of peanut butter. Since peanut butter is the most widely used *baiting gel* ingredient, it can mask the smell of sulfur. In the 1st to 4th replication at each dose, *Periplaneta americana* only gained weight consumption of *baiting gel* between 2 - 4 grams. This shows that sulfur is not a repellent or insect repellent because the amount of *baiting gel* consumption in this treatment is quite large, even though there is no mortality due to the low toxicity of sulfur.

The results of the three variations in sulfur dosages were not effective in killing *Periplaneta americana*. Seeing from previous research, namely the research conducted by Gani Bakhtiar (2020) with a combination of borax and sulfur doses can cause mortality because of the higher toxicity of borax than sulfur, besides that, the presence of borax can improve the texture of the *baiting gel* so it is very popular with cockroaches (Rifai, 2020).

D. Conclusions

There was no effect of the application of various sulfur dosages on *baiting gel* on mortality of *Periplaneta americana* imago

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