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The Effect of Mealworm as an Additional Bait to the Consumption of Malaysian Field Rat (*Rattus tiomanicus*) and Rice Field Rat (*Rattus argentiventer*)

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ABSTRACT

Rats is one of the important pest to human life, both in the agriculture and plantation, include rice field rat in rice and malaysian field rat in oilpalm. Various tactics and strategies have been conducted to control population of rat, one of them used poisonous bait (rodenticide). The attractiveness of poisonous bait is very important because rats do not like taste of the active ingredients of rodenticide. The aims of this research was to investigate the influence of mealworm (larvae of *Tenebrio molitor*) to the consumption of bait and poisonous bait. Therefore, it can increase the effective control to malaysian and rice field rat. There are four trial step in this research with choice test method. First trial, malaysian rat consumed more broken rice, while rice rat consumed more unhulled rice. Secondly, malaysian rat consumed more mealworm and broken rice, otherwise rice rat consumed more unhulled rice. Thirdly, the consumption of malaysian rat to mealworm showed significantlty difference with brodifacoum, while rice rat showed no difference. Fourthly, the consumption of malaysian rat to mealworm showed no significantly difference with bromadiolone, while rice rat showed difference. To increase the consumption of malaysian and rice field rats on rodenticides containing brodifacoum and bromadiolone, mealworm can be added as a flavoring to the rodenticide. By adding mealworm to rodenticide with a mixture of poisonous bait specifically for rats and placed in a special place for rats, it will increase rat's consumption to the point of killing them, while not inviting non-target animals to consume it and save to the environment.

Keywords: brodifacoum, broken rice, bromadiolone, larvae of *Tenebrio molitor*, unhulled rice.

INTRODUCTION

Agriculture is the main sector of the economy for most developing countries. Indonesia is a developing country that utilizes the agricultural sector as one of the main livelihoods of its population. This is because Indonesia's land area is very huge (1,919,440 km^2) and supported by a geographical structure with a tropical climate (6° North latitude - 11° South latitude and 95° - 141° East longitude). This is very suitable for the cultivation of various crops, included agricultural, horticultural, and plantation, so the development of the agricultural sector is considered strategic in Indonesia.

Efforts to increase agricultural products experience many obstacles, one of which is plant pest organisms. These plant pest organisms can cause economic losses to farmers and the community. Insect and rat are among the pests from the animal group. If the proliferation of this pest is allowed or it is too late to control it, it can cause economic losses (Sudarmaji and Herawati 2009). It causes a decrease in the quantity and quality of products, additional routine costs in farming, and disruption to agricultural cultivation steps (Djafaruddin 1995).

Rats are an important pest in human life, both in agriculture and plantations. Rats cause damage to rice, corn, sugar cane, coconut, and oil palm crops (Meehan 1984). In Indonesia, there are several species of rats that act as agricultural pests, two of which are malaysian field rat (*Rattus tiomanicus*) and rice field rat (*Rattus argentiventer*) (Priyam-bodo 2009).

Various control tactics and strategies have been used to control rats in the field. Broadly speaking, rat control can be grouped into several methods: Technical culture control (agronomic), sanitation, physical and mechanical control, biological control used natural enemies, and chemical control. The control of rats that is often carried out by the farmers or agriculture community is chemical using rodenticides or poisoned bait, although according to the integrated pest management (IPM) concept, this control is used as the last alternative if other methods do not provide optimal results.

Poisonous bait generally consists of poison or active ingredients, rat's bait, and additives. Based on how it works, the poison to rats is divided into two, namely acute poison which works quickly by damaging the nervous system and chronic poison which works slowly by inhibiting the coagulation or blood clotting process and breaking down blood capillaries inside organ. Apart from that, the effectiveness of using rodenticides in controlling rats, it requires considering the characteristics in choosing the right rats' bait (Priyambodo 2009).

Appropriate bait attraction is required because the poison used as rodenticide is not liked by rats. The feed ingredients in making poisonous bait are usually cereals, such as wheat, broken rice, unhulled rice, rice, and corn. Apart from cereals, small animals such as insect larvae can also be used as poisonous bait for rats. This depends on feeding habits and habitat conditions of rats. Apart from that, for normal growth, rats need carbohydrates, protein, and fat in a balanced manner (Nurihidayati 2010).

The aim of this research was to determine the effect of animal protein on the consumption of malaysia and rice field rat to rodenticides. It is hoped that this research can be a source of information about the effect of animal protein especially mealworm on the consumption of malaysian and rice field rat to rodenticides for optimal and effective control or management.

MATERIALS AND METHODS

Place and Time of Research

The research took place at the Vertebrate Pest Laboratory, Department of Plant Protection, Faculty of Agriculture, IPB University, Bogor District, West Java at 6° 26' South latitude and 106° 48' East longitude. This research lasted for two months.

Research Methods

Preparation of Test Animals

The test animals used in this research came from trees and shrubs at Darmaga Sub-district, Bogor District at 6° 26' (South latitude) and 106° 48' (East longitude) for malaysian field rat and from rice field area in Ciasem Sub-district, Subang District, West Java at 6° 30' (South latitude) and 107° 42' (East longitude) for rice field rat. The rats used were male and female, mature, healthy, and not pregnant. The body weight of rats was more than 70 g with a total of seven rats of each species per treatment or trial. The test rats that were successfully caught from the field were first acclimated in confinement in the Vertebrate Pest Laboratory, IPB University and given abundant rice food (*ad libitum*).

Preparation of Bait and Rodenticide

Ingredients used as bait such as rice, broken rice, unhulled rice, corn, and meal-worm were obtained from grocery stores, rice mills, and animal feed stores around the IPB Darmaga Campus and Bogor City. The

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rodenticide used is a chronic poison containing the active ingredients brodifacoum 0.005% and bromadiolone 0.005% obtained from a pesticide company.

Confinement Preparation

The cage used is a single cage with 50 cm length x 35 cm width x 40 cm height in dimension, made of aluminium, equipped with a drinking places, places to eat, and bamboo roof for rats to hide in.

Testing Methods

The **first** trial was the cereal bait choice test to find out the type of bait most consumed by malaysian field rat and rice field rat. The bait used was broken rice, unhulled rice, rice, and corn which were given each at 20 g for five consecutive days. The treatment was carried out with seven repetitions for each species of test rat. The **second** trial was carried out after the highest cereal consumption was obtained in the first test. Mealworm was used as animal protein which was tested with rodenticide containing the brodifacoum active ingredient and the cereals that were mostly consumed from the first test, using the multiple choice test method.

The cereal with the highest consumption at the first test was given 20 g, 10 g of mealworm, and 15 g of rodenticide containing the brodifacoum active ingredient, for four consecutive days. This test is to determine the bait that is most consumed among cereals, mealworm, and rodenticide. The treatment was carried out with seven repetitions for each species of test rat.

The **third** trial used bi-choice test between mealworm and rodenticide containing the brodifacoum active ingredient. Each treatment was given 20 g for three consecutive days with seven repetitions for each species of rats. The **fourth** trial used bi-choice test between mealworm and rodenticides containing the bromadiolone active ingredient. Each treatment was given 20 g for three consecutive days with seven repetitions to malaysian field rat and rice field rat.

Observed Variables

The variables observed were the level on the consumption of bait and rodenticide in malaysian field rat and rice field rat during observation, initial and final weights of test rats, number and duration of death of test rats, and consumption of test rats to rice after rodenticide treatment. To calculate the average weight of rats, the following formula is used:

$$\text{Average body weight of rats (g)} = \frac{\text{initial weight (g)} + \text{final weight (g)}}{2}$$

The following formula uses the ratio of bait and rodenticide consumption:

$$\text{The ratio of bait and rodenticide consumption (\%)} = \frac{\text{Bait or rodenticide consumption (g)}}{\text{Total consumption (g)}} \times 100\%$$

At each observation, bait and rodenticides that are not consumed, including those that are scattered on the bedding of the cage, are weighed. Then replaced with new ones for the next observation. Consumption data during observation was converted to 100 g of rats body weight, using the following formula:

$$\text{Bait/rodenticide conversion (g)} = \frac{\text{Bait/rodenticide consumption}}{\text{Average of rat's body weight}} \times 100$$

Data Analysis

The experimental design carried out was a Completely Randomized Design (CRD), for the first test with four treatments, the second test with three treatments, and the third and fourth tests with two treatments.

Each test contained seven repetitions for malaysia field rat and rice field rat. Processing of bait/rodenticide conversion data used Microsoft Office Excel 2010 software. Analysis of variance of the conversion data was carried out using the Statistical Analysis System (SAS) program for Windows 9.1.3 and continued with Duncan's Multiple Range Test (DMRT) at the α = 5% level.

RESULTS AND DISCUSSION

Cereal Bait Testing on Tree rats and Rice Field rats

Cereal bait testing on test rats can be seen in Table 1. The results obtained showed that malaysian field rats consumed the highest amount of broken rice and it was significantly different compared to unhulled rice, rice, and corn. Meanwhile, consumption of unhulled rice, rice, and corn has values that are not significantly different (Table 1).

Table 1. Consumption and ratio of consumption on malaysian field rat and rice field rat to rice and corn bait

Bait	Malaysian Field Rat			Rice Field Rat
	Consumption (g/100 g of body weight)	Ratio of consumption (%)	Consumption (g/100 g of body weight)	Ratio of consumption (%)
Broken Rice	6.137 a	58.36	4.030 a	40.86
Unhulled Rice	2.649 b	25.19	5.157 a	52.28
Rice	1.104 b	10.49	0.410 b	4.16
Corn	0.626 b	5.95	0.267 b	2.71
Total	10.516	100.00	9.864	100.00

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different based on Duncan's Multiple Range Test (DMRT) at the α = 5% level.

Thus, the cereal most preferred by malaysian field rats is broken rice and can be used as an attractive bait for this species of rat. Malaysian field rats are omnivores animal but tend to eat cereals or seeds (Aryata 2006). Rice field rats consumed broken rice and unhulled rice at a higher and significantly different rate compared to rice and corn. Thus, broken rice and unhulled rice are most preferred by rice field rats, so they can be used as attractive bait for this species of rat. Rice field rats food consumption depends on environmental conditions and rice planting. The ratio of consumption of malaysian field rats to broken rice (58.36%) showed the highest percentage compared to unhulled rice, rice, and corn. Meanwhile, the ratio of rice field rat's consumption of unhulled rice (52.28%) and broken rice (40.86%) shows almost the same percentage and is higher compared to rice and corn. According to the research results of Nugroho *et al.* (2009) rice endosperm, the base of the rice stem, grass fragments, and parts of dicotyledonous plants were found in the digestive tract of rice field rats. However, the staple food that rice field rats prefer is rice, which means unhulled rice and broken rice. Rats food requirements are approximately 10-15% of body weight and drinking water requirements are approximately 15-30 ml per day (Anggara and Sudarmaji 2008, Rohman *et al.* 2005). Based on the results of this test, broken rice for malaysian field rats and unhulled rice for rice field rats became cereal bait for the next trial.

Testing on Cereal Bait, Insect Larvae, and Rodenticides

Tests for broken rice or unhulled rice, mealworm, and brodifacoum can be seen in Table 2. The results obtained showed that malaysian field rats consumed broken rice and mealworm at a higher rate and were significantly different compared to brodifacoum. Thus, malaysian field rats prefer to consume broken rice and mealworm, while brodifacoum is not preferred. This is because malaysian field rats like cereal food which can be held by their two front legs and insect larvae which are found in their habitat (Priyambodo 2009). In general, consumption of broken rice is predicted to be greater and significantly different than that of mealworm because during normal growth rats need carbohydrates more, approximately 70%, while animal protein is less than carbohydrate, approximately 30%. The results of the observations showed that broken rice (46.29%) and mealworm (53.71%) were consumed in relatively the same ratio, meaning that these two baits were at the same level of palatability.

Table 2. Consumption and ratio of consumption of broken rice on malaysian field rat and unhulled rice on rice field rat to bait and rodenticide

Bait and Rodenticide	Malaysian Field Rat		Rice Field Rat	
	Consumption (g/100 g of body weight)	Ratio of consumption (%)	Consumption (g/100 g of body weight)	Ratio of consumption (%)
Broken Rice	5.579 a	46.29	---	---
Unhulled Rice	---	---	6.210 a	67.07
Mealworm	6.473 a	53.71	3.049 b	32.93
Brodifacoum	0.000 b	0	0.000 c	0
Total	12.052	100.00	9.259	100.00

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different based on Duncan's Multiple Range Test (DMRT) at the $\alpha = 5\%$ level.

Rice field rats consume the highest amount of unhulled rice and are significantly different from mealworm and brodifacoum. Thus, unhulled rice is preferable compared to mealworm and brodifacoum. Rice field rats also like mealworm while brodifacoum is not so it is not consumed. This shows that both unhulled rice (67.07%) and mealworm (32.93%) can be a good and appropriate mixture of poisonous bait for rodenticides. Consumption of malaysian field rats and rice field rats to brodifacoum (0 g) showed the lowest results among the three baits. Rats are easily suspicious of every object they encounter, including food, and are also deterrent to bait (Priyambodo 2009).

Testing of Mealworm Compared to Rodenticide Containing Brodifacoum

In this test, a bi-choice test method was carried out between mealworm and rodenticide containing brodifacoum as an active ingredient, against malaysian field rats and rice field rats for three consecutive days (Table 3). The test results showed that malaysian field rats consumed mealworm at a higher rate and were significantly different compared to brodifacoum. Thus, mealworm can be used as a mixture of bait with this rodenticide to control malaysian field rats.

Table 3. Consumption and ratio of consumption on tree rat and rice field rat to mealworm and brodifacoum

Bait and Rodenticide	Malaysian Field Rat		Rice Field Rat	
	Consumption (g/100 g of body weight)	Ratio of consumption (%)	Consumption (g/100 g of body weight)	Ratio of consumption (%)
Mealworm	8.649 a	79.85	3.294 a	73.56
Brodifacoum	2.183 b	20.15	1.184 a	26.44
Total	10.832	100.00	4.478	100.00

Note: Numbers in the same column followed by the same letter, indicate that they are not significantly different based on Duncan's Multiple Range Test (DMRT) at the $\alpha = 5\%$ level.

Rice field rat consumed more mealworm than brodifacoum, but the two baits are not significantly different. The percentage ratio in consumption of rice field rat to mealworm and brodifacoum showed almost the same results as malaysian field rat. The total consumption of rice field rat for mealworm and brodifacoum (4.478 g) is less than that of malaysian field rat (10.832 g). This showed that rice field rat consume only a small amount of mealworm and brodifacoum, because rice field rat have a higher level of suspicion compared to malaysian field rat. To increase the consumption of malaysian field rats and rice field rats on rodenticides containing the active ingredient brodifacoum, mealworms can be added as a flavoring to the rodenticide.

Testing of Mealworm Compared with Rodenticide Containing Bromadiolone

The consumption level of malaysian field rat to mealworm and rodenticide containing bromadiolone as an active ingredient showed that there were not significantly different even though the consumption ratio of mealworm (66.11%) was greater than that of bromadiolone (33.89%) (Table 4).

Table 4. Consumption and ratio of consumption on tree rat and rice field rat to meal-worm and bromadiolone

Bait and Rodenticide	Malaysian Field Rat		Rice Field Rat	
	Consumption (g/100 g of body weight)	Ratio of consumption (%)	Consumption (g/100 g of body weight)	Ratio of consumption (%)
Mealworm	9.774 a	66.11	5.256 a	99.62
Bromadiolone	5.011 a	33.89	0.020 b	0.38
Total	14.785	100.00	5.276	100.00

Note: Numbers in the same column followed by the same letter, indicate that they are not significantly different based on Duncan's Multiple Range Test (DMRT) at the $\alpha = 5\%$ level.

Judging from the consumption value of the test rats, malaysian field rat liked mealworm and this rodenticide because they consumed more than the rice field rat consumed to these two baits. If used to mix bait with rodenticide, it is still appropriate to use mealworm with rodenticide containing the active ingredient bromadiolone. Rice field rat consumed mealworm more and have a significantly different consumption ratio compared to bromadiolone. Judging from its consumption value, bromadiolone is almost not consumed (0.02 g) by rice field rats. Rice field rats prefer cereal food compared to block bait, bromadiolone formulations. The method used in this test is the preferred method. Thus, rice field rat prefer mealworm over bromadiolone because mealworm are another bait that is non-toxic and easy for rice field rat to handle (Utami 2012). Bromadiolone is designed as a rodenticide for house rat (*Rattus tanezumi*). This is because this type of rodenticide has a distinctive odor or more pungent for rats in residential areas so it is more effective when applied to house rats. To increase the consumption of malaysian field rat and rice field rat on rodenticides containing the active ingredient bromadiolone, mealworms can be added as a flavoring to the rodenticide.

Changes in Body Weight of Rats

Changes in body weight of malaysian field rat and rice field rat before and after testing can be seen in Figure 1. In each test, the body weights of malaysian field rat and rice field rat were weighed. The initial weight is obtained from weighing before testing, while the final weight is obtained from weighing after testing. The body weights of malaysian field rat and rice field rat were weighed to determine changes in their body weight.

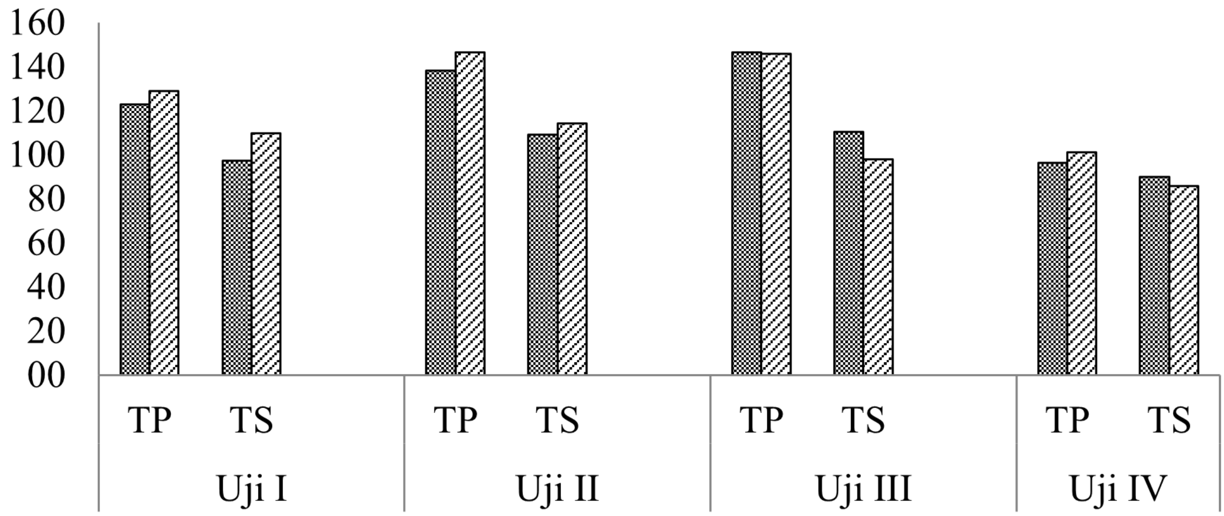

Figure 1 Histogram of change of body weight on malaysian field rats (TP) dan rice field rats (TS) before (▩) and after (▨) testing

In the first trial, malaysian field rat and rice field rat experienced an increase in body weight of 6.2 g for malaysian field rat and 12.7 g for rice field rat respectively (Figure 1). In this trial, the bait given was not poisonous so that the test rats experienced an increase in body weight. In the second trial, malaysian field rat and rice field rat also experienced an increase in body weight of 8.3 g and 5.4 g respectively. This is because malaysian field rat and rice field rat did not consume the rodenticide given during testing, so the body weight of the test rats continued to increase.

In the third trial, malaysian field rat and rice field rat experienced a decrease in body weight because they were given bait and rodenticide. Malaysian field rat experienced a decrease of 0.6 g, while rice field rats experienced a decrease of 12.2 g. In the fourth trial, there were different results for each type of rats tested, malaysian field rat experienced an increase in body weight of 4.8 g, while rice field rat decreased by 4.1 g. In general, when testing with bait containing rodenticide, the body weight of the test rats will decrease. Malaysian field rat's consumption on mealworm is still higher than bromadiolone, resulting in an increase in body weight.

Rat Death Rate and Duration

The rate and duration of death on malaysian field rat and rice field rat can be seen in Table 5. Death (mortality) of test rats occurred in third trial and fourth trial. The percentage of mortality and duration of death in each species of rat in the third trial was greater and shorter than in the fourth trial. The mortality of malaysian field rat was 85.71% with a death time of 3.7 days in third trial, while in fourth trial mortality was 57.14% with a death time of 5.3 days. In the third trial, mortality of rice field rat was 42.86% with a time of death of 2.7 days, while in fourth trial mortality was 28.57% with a time of death of 4.0 days.

Table 5. Rate and duration of death of malaysian field rat and rice field rat in the third trial and fourth trial

Rat Species	Third Trial		Fourth Trial	
	Mortality (%)	Length of death (day)	Mortality (%)	Length of death (day)
Malaysian Field Rat	85.71	3.7	57.14	5.3
Rice Field Rat	42.86	2.7	28.57	4.0

Malaysian field rat’s consumption in the third trial was different from consumption in the fourth trial, resulting in different rates and duration of death. Consumption of malaysian field rat in third trial had many and significantly different rates, resulting in a high death rate and a short death time. Rice field rat consumption in third trial was also different from consumption in fourth trial. This is because the rice field rats in fourth trial consumed a lot of mealworm while almost no bromadiolone was consumed, so the mortality rate was lower and the duration of death was longer than in third trial.

Post Treatment Consumption of Malaysian Field Rat to Broken Rice and Rice Field to Unhulled Rice

The consumption of test rat to broken and unhulled rice after the third and fourth test trial can be seen in Table 6. After testing for three consecutive days, the malaysian field rat were fed broken rice and rice field rat were fed unhulled rice for seven consecutive days. This post treatment feeding aims to observe the duration of death and post poisoning consumption of malaysian and rice field rat, that have consumed rodenticides. Based on Table 6 in third and fourth test, food consumption of malaysian field rat was lower than rice field rat, although it is not significantly different. This occurs because the consumption of malaysian field rat to rodenticides during testing is large enough to disrupt the physiological processes and can reduce the consumption of broken rice.

Table 6. Consumption of malaysian field rat to broken rice and rice field rat to unhulled rice after the third and fourth test

Rats Species	Third Test	Fourth Test
Malaysian Field Rat	3.819 a	5.740 a
Rice Field Rat	4.839 a	6.384 a

Numbers in the same column followed by the same letter, indicate that they are not significantly different based on Duncan's Multiple Range Test (DMRT) at the $\alpha = 5\%$ level.

In the third trial, the test rat's consumption was smaller than in fourth trial. This is also because the test rat's consumption to brodifacoum was greater than the consumption to bromadiolone. Thus, the poisoning process is stronger and the mortality rate is greater and the duration of mortality is faster.

GENERAL DISCUSSION

Application of rodenticides for pest rats: 1. Factory-made block-shaped rodenticides, ground or crushed and then mixed with crushed mealworm with a certain concentration, so that it can cause a good taste for pest rats to eat more of this rodenticide (rat poison) and kill them. This also means that rats do not eating sub-lethal doses of poison, that will make them physiologically resistant to the poison. 2. Rice farmers in Java Island are accustomed to mixing acute poison, namely zinc phosphide, with grain or rice grains that have been coated with vegetable oil (cooking oil) and given to rice field rats when the population is very high to control the population of these pest rats. The vegetable oil coating can be added with crushed mealworm to increase the palatability of rats to anticoagulant rodenticides (brodifacoum and bromadiolone).

Efforts to prevent the dangers of rodent poison bait combined with mealworm against non-target pests and environmental health:

1. In the manufacture of anticoagulant rodenticides (bait blocks) in factories to control pest rats, two ingredients have been added, namely paraffin and bittering agents. The paraffin added to this rodenticide aims to increase the durability or physical resistance of this rodenticide when applied in the field (it can last for more than two weeks). Physical or abiotic factors that will affect the durability of this rodenticide in the field are sunlight (high temperature), rainfall (high humidity), wind, and several other environmental factors.
2. The addition of this paraffin can also prevent this rodenticide from being eaten by non-target animals because the paraffin can reduce the palatability of non-target animals to this poisonous bait. However, the addition of this paraffin does not reduce the palatability of pest rats because pest rats tend to eat the bait (rice and corn) and the poison it contains and leave the paraffin in the rodenticide.

3. The addition of bittering agents will make non-target animals that consume this rodenticide taste bitter, so they will vomit the rodenticide when chewed before swallowing it. These bittering agents are actually intended for humans, especially small children who do not understand that this block-shaped rodenticide is intended to kill pest rats. Meanwhile, the addition of these bittering agents does not affect the rats that consume it because it is not felt on the tongue or taste organs. In addition, giving rodenticide that has been crushed and added with mealworm will cover the bitter taste.
4. Application of rodenticide in the field must be placed in natural places such as bamboo tubes, coconut shells, and other natural materials, with entrance holes that are limited in size, namely only suitable for the head and body of pest rats, so that they cannot be entered or taken by non-target animals (such as squirrel, moongose, and civet).
5. The active ingredients of anticoagulant rodenticides (chronic poisons) such as brodifacoum and bromadiolone, work differently from the active ingredients of other pesticides, such as insecticides, fungicides, and herbicides. The active ingredients of other pesticides are generally contact poisons and work on the nervous system of the target animal so that they will be harmful to the environment and non-target animals. The active ingredients of anticoagulant rodenticides work as blood coagulation inhibitors (anticoagulation) which are only found in mammals. Likewise, they work as stomach poisons, which means they must be eaten first by the target to then work starting in the target's digestive system. Thus, the active ingredients of these rodenticides are relatively safe for environmental health.

CONCLUSIONS AND SUGGESTION

Conclusion

Malaysian field rats and rice field rats prefer cereal food such as broken rice and unhulled rice. Malaysian field rat consumed more mealworm and broken rice, otherwise rice field rat consumed more unhulled rice. The consumption of malaysian field rat to mealworm showed significantlty difference with brodifacoum, while rice field rat showed no difference. The consumption of malaysian field rat to mealworm showed no signifi-cantly difference with bromadiolone, while rice field rat showed difference. To increase the consumption of malaysian and rice field rats on rodenticides containing the active ingredient brodifacoum and bromadiolone, mealworm can be added as a flavoring to the rodenticide. Malaysian and rice field rats consumed rodenticide containing brodifacoum more than bromadiolone, causing high mortality of rats and short death times. Malaysian field rats consumed rodenticide more than rice field rats, this causes the consumption of malaysian field rats to rice after trial to be lower than that of rice field rats. By adding mealworm to this rodenticide for rats with a mixture of poisonous bait specifically for rats and placed in a special place for rats, it will increase rat consumption to the point of killing them, while not inviting non-target animals to eat them.

Suggestion

Further testing is needed to other rats species that play an important role as a pest, and rodenticide with different active ingredients to determine the effect of animal protein bait on the consumption to rodenticide. Likewise, it is necessary to test the addition of mealworm to rodenticides that have been crushed against non-target animals such as rodents other than rats, squirrel (*Callosciurus notatus*) and rat predators from the mammal class such as moongose (*Herpestes javanicus*) and moon civets (*Viverricula malaccensis*).

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