Study on the feeding behaviour of house shrew (*Suncus murinus* L.) in Bogor to feed and rodenticide

Swastiko Priyambodo*, Rianita Septiana

Department of Plant Protection, Faculty of Agriculture, IPB University
*Corresponding author: swastiko@apps.ipb.ac.id

Received: 14 December 2021 / Approved: 28 September 2022

ABSTRACT

Shrew is an animal belong to small mammals that the existence must be noticed because it has defecation behavior and their droplets often pollutes the house. Shrew can be vectors in the spread of infectious diseases to human. Shrew management has not been conducted well. Information about the most preferred bait and the effective rodenticide as a reference in controlling is not widely known. Chemical control using rodenticides is effective enough and does not take a long time. The objective of this research was to obtain shrew preference to the types of feed that commonly consumed by human and rodenticide to control it. It can be used as bait in trapping and poisoned bait which are effective in shrew management. Baits that used were cooked rice, rice, white bread, Tenebrio larvae, cricket, chicken nugget, fish meatball, and salted fish. Choice tests were used by serving eight feeds in one cage for seven consecutive days in the first test. Then, choose four prefered feeds and tested for seven consecutive days in the second test. Acute poison (zinc phosphide) and chronic poison (coumatetralyl) mixed with the most preferred feed, then served with control feed as comparison for the third test. Result of this research showed that cricket was the most preferred feed therefore it can be used as trap bait or poisoned bait. Moreover, the other most preferred feed is Tenebrio larvae, fish meatball, and cooked rice that can be used as substitution feed if crickets are difficult to find. Zinc phosphide rodenticide is more effective than coumatetralyl to kill shrew with relatively fast on the time of death.

Keywords: acute and chronic poison, house shrew, settlement pests.

INTRODUCTION

Residential pests are one of the problems that are often faced by the community in urban area, because their presence can cause various diseases and damage aesthetics. Problems that arise due to residential pests depend on the level of danger, loss or disturbance, population, and the level of human tolerance for their presence in the residential environment (Sigit *et al.* 2006). Residential pests are divided into two types, namely insects and rats. Several types of pest such as rats, mosquitoes, cockroaches, termites, and flies can be found in office buildings, housing, apartments, and factories. During the rainy season, the pest population will increase, but few people care to control these pests (Nafis 2009). In addition to rats and insects, one of the other residential pests is shrew.

Shrew is a type of animal that has similarities to rodents (Order Rodentia) (Liat 2015). The house shrew belongs to the Order Soricomorpha, Family Soricidae, Genus Suncus, and Species *Suncus murinus* L. (Lench 2004). This species is widely distributed in Southern Japan, Southern China, Southeast Asia, Sri Lanka, coastal areas of the Arabian Peninsula and Iran, Madagascar, coastal areas of East Africa, and many small islands in the Indian Ocean (Hutterer 2005; Motokawa 2015). The house shrew (*S. murinus*) has morphological characteristics in the form of a pointed snout and a gray body color, with a size of about 1.5 times larger than that of mice (Liat 2015). According to Shoma *et al.* 2016, shrew body size is controlled by genes and environmental factors (temperature, geography, geoecology, and isolation). The body length of the shrew is about 130-180 mm, with a tail length of 75-120 mm and a head 32-42 mm. The body weight of the male shrew is greater than that of the female. The average body weight of male shrews in Bangladesh 135.5 g and 82 g in females. Meanwhile, shrews in Nagasaki, Japan is smaller, 52.9 g in males and 34.2 g in females (Ishikawa and Namikawa 1987). The shrew has 6 mammary glands and can give birth to an average of 4 cubs (Liat 2015).

Shrew can be found around human habitation (settlements), urban and sub-urban areas, and associate with humans in foraging activities or nesting sites (Widiastuti *et al.* 2016; Priyambodo 2002). In addition, shrews are also found in meadows, roads, parks, and sewers in housing (Priyambodo 2002). Shrews are active at night (nocturnal) and active on land (terrestrial). These animals eat a lot of insects (insectivores) so they can control the population of insect pest in the house, such as cockroaches, crickets, and other insects that are attracted to lights, but also often eat leftovers in the kitchen, such as rice, meat, and vegetables. However, shrews are a type of small mammal whose presence must be watched out for because it can cause discomfort. This happens because shrews have frequent bowel movements (defecation) and their feces can contaminate the house. Its presence can cause an unpleasant odor as a form of self-defense from natural enemies. In addition, these animals can also play a role in the spread of infectious diseases in humans (Liat 2015). Transmission of disease can occur through

DOI: https://doi.org/10.21107/agrovigor.v15i2.12918
Copyright (c) 2022 Author (s)

ISSN: 1979-5777 (*Print*), 2477-0353 (*Online*)

contamination of food and water consumed by humans with droplets and urine excreted by shrew.

One of the diseases that can be transmitted by shrews is leptospirosis. Leptospirosis is a disease caused by infection with the bacteria Leptospira sp. which can be transmitted through domestic animals, such as cattles, pigs, dogs, and cats as well as rodents, especially rats (Sholichah dan Rahmawati 2017; Kusmiyati *et al.* 2005). The transmission of leptospirosis by shrew is less than that of rat, thus the control efforts against shrew are still few.

Research on the type of bait as a reference in controlling shrews has not been done much. Chemical control as the last step in integrated pest control (management) is still not widely and optimally carried out on shrew. The use of chemicals such as rodenticides has the advantage that it is easy to obtain at low prices and easy to apply, but with the disadvantage of having a broad spectrum, so it can affect non-target organisms. Rodenticides are generally a reference or basis for rodent pest management strategies in the world.

Based on the mode of action, the active ingredients of rodenticides consist of acute and chronic (anticoagulant) poisons. Acute poisons work quickly, which can cause death within 1-2 days, while death from chronic toxins occurs within 5 days (Syahputri & Priyambodo, 2020). The way acute poison works is to damage the nervous system by causing seizures and paralysis. In addition, it can also produce phosphine (PH_3) gas in the stomach and if death does not occur overnight then the poisoning that occurs is characterized by liver damage (Priyambodo 2009; USDA 2019). Meanwhile, chronic toxins work slowly, by disrupting the vitamin K cycle in the blood clotting process so that internal bleeding occurs due to ruptured capillary blood vessels with external symptoms in the form of bleeding through natural holes, such as the eyes, nose, mouth, ears, and anus (Buckle 2012; Priyambodo 2009; Sinaga *et al.* 2017)

MATERIAL AND METHOD

Research Method

The research was conducted at the Vertebrate Pest Laboratory, Department of Plant Protection, Faculty of Agriculture, Bogor Agricultural University. The research was conducted from September 2019 to January 2020.

Test Animal Preparation

The house shrew test animal was obtained from the results of catching around the settlement of Cikarawang Village, Dramaga, Bogor. The test animals used were 23 house shrews. The criteria for test animals that can be used are: Not pregnant, body weight more than 35 g, and in healthy condition. The house shrews obtained were weighed and their sex and feed requirements were recorded (20% body weight). Then, the shrews were transferred to a test cage which had been checked for cleanliness and suitability, and a bamboo piece, a bowl filled with drinking water and feed had been placed.

Bait and Rodenticide Preparation

The baits used in this test were cooked rice, rice, white bread, hongkong caterpillar (Tenebrio larvae), cricket, chicken nugget, fish meatball, and salted fish which were obtained from shops around the IPB University, Dramaga, Bogor. The rodenticide used was an acute poison with an active ingredient of zinc phosphide with a concentration of 80%, in the form of black powder and a chronic poison with an active ingredient of coumatetralyl with a concentration of 0.75%, in the form of a blue powder. Concentrations of toxic use in bait or feed was 1% for zinc phosphide and 5% for coumatetralyl. Rodenticide flour is mixed with the most consumed feed. The mixture of feed and rodenticide is placed in a bowl of 7-15 g. The mixture is given to the shrews and the amount of consumption is calculated to determine the most preferred feed and the most effective poison.

Feed Test

Feed testing was carried out to determine the type of feed consumed by the shrews the most. The feed used in this test were cooked rice, rice, white bread, hongkong caterpillar (Tenebrio larvae), cricket, chicken nugget, fish meatball, and salted fish. Feed testing was carried out by the choice test method for 7 consecutive days by feeding 20% of the shrew's body weight.

The method of choice test is carried out in three stages of testing. The first test was carried out by giving 8 different types of feed to 5 shrews as replication which were tested for 7 consecutive days in each cage. Then, it was found that the 4 most feeds were consumed by shrews. The four feeds were tested in the second stage of testing for 7 shrews as replication for 7 consecutive days. This test will show the final result in the form of the most preferred feed of all types of feed. Furthermore, rodenticide testing was carried out for 11 shrews for 7 consecutive days. Observations were made twice a day, in the morning (07.00-09.00 am) to calculate the consumption of bait during the night and in the afternoon (4.00-6.00 pm) to calculate consumption during the day.

The first step in testing the feed is weighing the shrews to determine the amount of feed given and to determine changes in body weight before and after treatment. The control of shrew feed in this test is needed to determine the shrinkage due to water content in the feed. Each feed used as a control was placed outside the cage. Controls were weighed and changed twice a day in the morning and afternoon. From the results of weighing body weight and calculating the amount of feed, then the feed can be weighed as needed. The weighed feed was placed in a test cage. The tests carried out included observing the body weight of the shrew before and after treatment. Observations were made by weighing the remaining feed, including that which was scattered at the bottom of the cage. Calculation of shrew feed is done by reducing the amount of feed before and after. Then, feed consumption was converted to control and 100 g of body weight.

$$\text{Evaporation (\%)} = \frac{\text{Initial feed quantity} - \text{leftover feed}}{\text{Initial feed quantity}} \times 100\%$$

Actual consumption (g) = [100% - (% evaporation)] x consumption of shrew

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

$$\text{Feed conversion (g)} = \frac{\text{Actual consumption (g)}}{\text{Average body weight (g)}} \times 100\%$$

Rodenticide Test

Rodenticide testing was conducted to determine the preferences and effectiveness (efficacy) of acute and chronic rodenticides against house shrews. The method used is a test with a choice (choice test). The test animals obtained were put into a test cage that had been given a bamboo roof, a bowl filled with drinking water and feed. Three feed containers were provided in each cage, namely control (cricket), a mixture of cricket with zinc phosphide, and a mixture of cricket with coumatetralyl. Observations were made for 7 consecutive days. Observations were made by weighing the remaining feed, including that which was scattered at the bottom of the cage. The dead shrews were weighed and observed for signs of death. After seven days of observation, if there are shrews that are still alive, then the test was stopped and the shrews were fed with cricket as much as 20% of their body weight for seven days of observation.

Lethal dose (LD)

Lethal dose of rodenticide against shrew is obtained from the following formula:

$$\text{Lethal Dose (ppm)} = \frac{\text{Consumption of poison (mg)}}{\text{Body weight of shrew (kg)}}$$

Amount of poison consumed (mg) = consumption of toxic feed (mg) x concentration of poison in formulation (%) x concentration of rodenticide in toxic feed (%)

Data analysis

The experiment was conducted using a completely randomized design (CRD). The consumption data was inputted into Microsoft Office Excel 2010 and analyzed for variance (ANOVA) using the Statistical Analysis System (SAS) for Windows v.9.4 application program. Then the mean value was further tested with Tukey's test at a significant level (α) of 5% and 1%.

RESULTS AND DISCUSSION

Feed Preference in the First Test

Feed Preference During the Day and Night

The average consumption of each type of feed for 5 shrews can be seen in Table 1. The test results during the day showed that crickets were the most consumed feed followed by rice, fish meatball, and white bread. Shrews consume more feed containing carbohydrates than protein during the day. Most carbohydrates were obtained from cooked rice, white bread, and about 35.69% (100% minus 64.31%) a mixture of tapioca flour, preservatives, and flavorings in fish meatball. Rice contains 19.43% carbohydrates, when cooked it will increase with the length of heating (Thawil and Bahar 2013). White bread made from wheat flour contains carbohydrates of 59.40% (Rahmah *et al* 2017).

The results of the analysis showed that crickets were not significantly different from cooked rice, fish meatball, and white bread (Tukey's test =5% and 1%). However, cricket was significantly different from chicken nugget, hongkong caterpillar (Tenebrio larvae), salted fish, and rice (α=5%). Based on Tukey's test =1%, cricket was significantly different from Tenebrio larvae, salted fish, and rice, but not significantly different from chicken nugget. In addition, it was found that among the 7 feeds other than cricket, there was no significant difference from each other (α=1%), so that the seven feeds had the same chance of being eaten by shrew during the day.

The test results at night showed that cricket was the most consumed feed followed by fish meatball, cooked rice, and hongkong caterpillars (Tenebrio larvae). Shrew eat more protein-containing feed than carbohydrates at night. Protein was obtained from cricket, hongkong caterpillar, and about 64.31% surimi content in fish meatball which was known from the information on the composition of the product used. Cricket contain high enough protein, which is around 40-55% with essential and semi-essential amino acids (Panjaitan et al., 2012). Tenebrio larvae contains 58.5% protein in the form of dry flour (Aguilar *et al.* 2001). Surimi is a stable myofibril protein found in fish meat that has been separated from the

©2022 Swastiko Priyambodo, Rianita Septiana

Table 1. Feed preference of shrew at day, night, and combined in the first test

Feed	Mean Consumption			Percentage Consumption		
	Day	Night	Combined	Day	Night	Combined
	(g/100 g body weight)[a]			(%)		
Cricket	6.44 aA	12.31 aA	9.38 aA	29.73	49.36	40.24
Cooked rice	4.11 abAB	3.36 bB	3.74 bB	18.98	13.47	16.04
Fish meatball	3.57 abcAB	3.53 bB	3.55 bBC	16.48	14.15	15.23
White bread	3.16 abcdAB	1.75 bB	2.46 bcBC	14.59	7.02	10.55
Chicken nugget	2.79 bcdAB	1.22 bB	2.00 bcBC	12.88	4.89	8.58
Tenebrio larvae	1.26 bcdB	2.60 bB	1.93 bcBC	5.82	10.43	8.28
Salted fish	0.27 cdB	0.01 bB	0.14 cC	1.25	0.04	0.60
Rice	0.06 dB	0.16 bB	0.11 cC	0.28	0.64	0.47
Total	21.66	24.94	23.31	100	100	100

[a] Numbers in the same column followed by the same letter, showed no significant difference based on Tukey's test at =5% (lowercase) and =1% (capital letter).

bone and skin then ground and washed and mixed with cryoprotectant (Moniharapon, 2014). Cricket was significantly different from 7 other feeds given (Tukey test =5% and 1%). While fish meatball, cooked rice, Tenebrio larvae, white bread, chicken nugget, rice, and salted fish were not significantly different from each other, so that the seven feeds had the same opportunity to be consumed by shrew at night.

Combined Day and Night Feed Preference

Based on the results of the first test, cricket, cooked rice, fish meatball, and white bread were the 4 most consumed feeds among the eight feeds provided. Of the eight feeds given, cricket was the most preferred feed, as shown from the results of the analysis that were significantly different from 7 other feeds (Tukey Test =5% and 1%) with the highest consumption percentage, which was 40.24%. This is because shrew eat a lot of insects (insectivores), but also often eat leftovers in the kitchen, such as rice, meat, and vegetables (Liat 2015).

Furthermore, the most consumed feeds are cooked rice, fish meatball, and white bread. Cooked rice was significantly different from salted fish and rice, but not significantly different from fish meatball, white bread, chicken nugget, and Tenebrio larvae (Tukey Test =5% and 1%). This shows that shrew prefer relatively soft-textured feed, even though they are more likely to consume salted fish and rice with a harder texture.

Of the eight types of feed given, cricket showed the highest percentage of consumption during the day, night, and combined (day and night average). The percentage of cricket consumption during the day was 29.73%, at night was 49.36%, and a combined was 40.24%. Shrew consumed more cricket at night. This is because shrew is nocturnal animal (Liat 2015).

Feed Preference in the Second Test

Feed Preference During the Day and Night

The average consumption of each feed for 7 shrews can be seen in Table 2. Based on the results of the first test of combined day and night feed preferences, the 4 most consumed feeds were cricket, cooked rice, fish meatball, and white bread for the second test. However, Tenebrio larvae were used as a substitute for white bread in this test. The use of Tenebrio larvae aims to determine the feed preference of shrew as insectivores against the two types of insects provided.

The test results during the day showed that cricket was the most consumed, followed by cooked rice, fish meatball, and Tenebrio larvae. Shrew consumed more feed containing carbohydrates than protein during the day. Carbohydrates are obtained from cooked rice and about 35.69% (100% minus 64.31%) a mixture of tapioca flour, preservatives, and flavoring in fish meatball. Cricket was significantly different from fish meatball and Tenebrio larvae, but not significantly different from cooked rice (Tukey Test =5% and 1%). In addition, cooked rice was significantly different from Tenebrio larvae and not significantly different from fish meatball (Tukey test =5% and 1%).

Table 2 Feed preference of shrew at day, night, and combined in the second test

Feed	Mean Consumption			Percentage Consumption		
	Day	Night	Combined	Day	Night	Combined
	(g/100 g of body weight)[a]			(%)		
Cricket	4.61 aA	12.21 aA	8.41 aA	42.69	44.34	43.87
Tenebrio larva	0.61 cC	10.01 aA	5.31 bAB	5.65	36.35	27.70
Cooked rice	3.04 abAB	2.61 bB	2.82 bB	28.15	9.48	14.71
Fish meatball	2.54 bBC	2.71 bB	2.63 bB	23.52	9.84	13.72
Total	10.80	27.54	19.17	100	100	100

[a] Numbers in the same column followed by the same letter, showed no significant difference based on Tukey's test at =5% (lowercase) and =1% (capital letter).

The test results at night showed that cricket was the most consumed, followed by Tenebrio larvae, fish meatball, and cooked rice. Shrew eat more protein-containing feed than carbohydrates at night. Protein is obtained from cricket, Tenebrio larvae, and about 64.31% content in fish meatball. Cricket was significantly different from fish meatball and cooked rice, but not significantly different from Tenebrio larvae. In addition, fish meatball was not significantly different from cooked rice (Tukey test =5% and 1%).

Combined Day and Night Feed Preference

The most consumed feed was cricket followed by Tenebrio larvae, cooked rice, and fish meatball. Cricket was significantly different from the other three feeds (α=5%), but not significantly different from Tenebrio larvae (α=1%). Shrew has a tendency to consume more Tenebrio larvae than cooked rice and fish meatball, so Tenebrio larvae can be used as a substitute for cricket. Of the four types of feed given, cricket showed the highest percentage of consumption during the day, night, and combined (day and night average). The percentage of cricket consumption during the day was 42.69%, at night 44.34%, and a combined 43.87%. In addition, the Tenebrio larvae also has the highest consumption percentage in second place. The percentage of Tenebrio larvae consumption during the day was 5.65%, at night 36.35%, and a combined 27.70%. Shrews consumed more Tenebrio larvae and cricket at night. This is because shrews are insectivores and are nocturnal (Liat 2015)

Feed and Rodenticides Preference on the Third Test

Feed Preference in Day and Night

Based on the results of first and second test, cricket was used as feed to be used in the third test. The average consumption of each feed for 11 shrews can be seen in Table 3. Control feed (non-toxic cricket) was the most effective feed, widely consumed during the day, followed by coumatetralyl, and zinc phosphide. The three feeds given during the day were not significantly different from each other (Tukey's test =5% and 1%). This showed that shrew has low neophobic behaviour because it tends to consume all three types of feed evenly during the day. Neophobic behaviour is defined as a fear of something new or avoiding unfamiliar objects (smell, taste, sound, and foreign foods) that are around them (Putri 2012).

Control feed was the most consumed feed at night, followed by coumatetralyl and zinc phosphide. The control feed was significantly different from the other two feeds. This indicates that shrew tend to consume more control feed without poison at night. A sense of smell and taste in shrew develops better at night. Meanwhile, the average consumption to zinc phosphide and coumatetralyl poison feed was relatively the same during the day and night.

Tests of feed and rodenticide preferences that have been carried out place coumatetralyl as the most consumed feed in second place. Mixture of cricket feed with coumatetralyl was consumed more than zinc phosphide. This happens because chronic rodenticides do not cause a pungent odor or aroma in the bait provided so that the shrews are not suspicious (Syahputri & Priyambodo, 2020). Meanwhile, zinc phosphide has a pungent garlic-like aroma (Buckle 2012).

Day and Night Combined Feed Preference

Tests of combined feed preferences during the day and night, showed that crickets without poison were most consumed by shrews, followed by a mixture of crickets and comatetralil, as well as a mixture of crickets and zinc phosphide. Non-toxic crickets (control) were significantly different from a mixture of crickets and comatetralil and a mixture of crickets and zinc phosphide (Tukey's test =5% and 1%). This shows that shrew prefer control cricket compared to mixed cricket with poison. Nevertheless, the two mixtures of cricket with the poison were still consumed until they reached a consumption percentage of 43.46%, as evidenced by the death in 4 out of 11 shrews tested due to poisoning. Of the three types of feed given, control cricket showed the highest percentage of consumption during the day, night, and combined. The percentage consumption of control crickets during the day was 41.52%, at night 65.26%, and a combined 56.54%.

©2022 Swastiko Priyambodo, Rianita Septiana

Table 3 Feed preference of shrew on day, night, and combined on the third test

Feed	Consumption			Percentage		
	Day	Night	Both	Day	Night	Both
	(g/100 g body weight)[a]			(%)		
Control	4.38 aA	11.31 aA	7.91 aA	41.52	65.26	56.54
Coumatetralyl	3.21 aA	3.70 bB	3.43 bB	30.43	21.35	24.52
Zinc phosphide	2.96 aA	2.32 bB	2.65 bB	28.06	13.39	18.94
Total	10.55	17.33	13.99	100	100	100

[a] Numbers in the same column followed by the same letter, showed no significant difference based on Tukey's test at =5% (lowercase) and =1% (capital letter).

Table 4 Rodenticide efficacy to the death of shrew

No. of Animal	Death in-(days)	Total length (mm)/ Sex	Consumption of Poison		Body weight of shrew (kg)	Lethal Dose	
			Zinc phos.	Coumat etra.		Zinc phos.	Coumatetr a.
			(mg)			(ppm)	
1	Survive	210/M	49.37	2.58	0.06285	785.51	41.03
2	2	180/F	80.03	3.69	0.03297	2427.37	112.03
3	Survive	170/F	59.85	3.94	0.04004	1494.73	98.41
4	Survive	215/M	30.52	1.37	0.05745	531.22	23.87
5	Survive	210/M	29.44	3.33	0.05476	537.53	60.86
6	Survive	195/M	29.32	1.48	0.05247	558.73	28.18
7	3	200/M	40.44	3.91	0.05444	742.77	71.86
8	Survive	175/F	37.85	2.18	0.04102	922.64	53.13
9	Survive	215/M	28.19	1.48	0.05491	513.43	27.04
10	5	210/M	29.92	2.67	0.05469	547.11	48.75
11	2	200/M	49.19	1.89	0.04692	1048.44	40.19

Sex: M (male); F (female)

Rodenticide Efficacy

The rodenticide efficacy or the effectiveness test which was carried out in conjunction with feed preferences with rodenticides resulted in 4 dead shrews with certain symptoms. Data on sex, day of death, body length, amount of poison consumed, and lethal dose can be seen in Table 4. The dead shrews were known to consume a mixture of feed with more toxins than control feed. Meanwhile, the other seven shrews that were still alive consumed relatively more control feed. This happens because the test animals that are still alive are encouraged to eat more baits to obtain energy to detoxify (the process of removing toxins) at sub-lethal doses that enter their bodies (Wiratno et al., 2011).

According to Fatmawati (2015), the death of test animals in rodenticide treatment was caused by test animals consuming a lethal dose of rodenticide, while test animals that were still alive consumed rodenticide at a non-lethal dose (sub-lethal dose). This is in accordance with the incidence of death in shrews. The 2, 7, 10, and 11 shrew deaths occurred due to shrew consuming zinc phosphide and coumatetralyl poison at a high enough lethal dose. However, the lethal dose of poison consumed by the four shrews was not the highest lethal dose out of the eleven shrews tested, except for 4. Shrew 4 consumed zinc phosphide and coumatetralyl poison with the highest lethal doses, 2427.37 ppm and 112.03 ppm respectively. The difference in lethal doses in each individual shrew occurs due to physiological factors, namely the immune system is different in each individual shrew so that it affects the processes that occur in the body (Ridatiningsih 2017).

The lethal dose of house shrew to zinc phosphide is around 513-2427 ppm and coumatetralyl 23-112 ppm. This figure is higher than the LD_{50} for zinc phosphide and coumatetralyl in rats, 40 ppm and 16 ppm respectively (Priyambodo 2009; Djojosumarto 2008). This shows that shrews have a higher body resistance than rats. Some shrews are known to survive despite consuming large amounts of poison. This is because the shrews experience an escape or survive condition, where the poison that enters the body of shrew is immediately decomposed (detoxified) by the internal organ (liver) of shrew (Fatmawati 2015). Detoxification occurred when the shrews consumed higher amounts of non-toxic (control) feed.

Changes in Body Weight and Poisoning Symptom

Change in body weight of shrew and symptoms of poisoning due to rodenticides vary. Shrew No. 2 died with decreased body weight from 35.67 g to 30.26 g. Internal symptoms are not clearly observed because the shrews have started to rot. Shrew No. 7 died with a decreased body weight from 56.20 g to 52.68 g. Symptoms in the form of a pale light brown liver. Shrew No. 10 died with decreased body weight from 55.30 g to 54.08 g. Symptoms in the form of a greenish-yellow liver and blue-black intestines. Shrew No. 11 died with constant body weight from 46.86 g to 46.98 g. Symptoms in the form of clear bubbles and necrotic lesions or black spots on the intestines.

Shrews No. 2 and 11 consumed higher amount of zinc phosphide than coumatetralyl and relatively the same as control feed, died in 2 days. The consumption of shrews No. 7 and 10 to zinc phosphide, coumatetralyl, and control feed were relatively the same, died in 3 and 5 days. However, the actual amount of poison consumed more is zinc phosphide which kills faster. This was due to the toxin concentration of zinc phosphide in the rodenticide formulation was 80%, while that of coumatetralyl was only 0.75%. The higher the concentration of poison, the higher and the faster on the mortality of the test animals (Herawati & Sudarmaji, 2009).

In addition, the death of shrew is also influenced by the different responses of the body to toxins in each individual. The internal symptoms caused by zinc phosphide tend to be different, namely changes in liver color from brownish red to yellowish green or pale light brown. The difference can be compared between shrews that died from poisoning and shrews that remained alive after consuming poison (survive). In addition, discoloration also occurs in the intestines, from yellowish white to blackish blue or black spots. This is in accordance with the symptoms of zinc phosphide poisoning in Tripathi (2014), which states that when ingested, acid from zinc phosphide that enters the stomach will release deadly phosphine gas (PH_3), producing symptoms in the form of necrotic lesions and kidney damage, causing kidney failure, heart and liver damage.

CONCLUSION

The feed most consumed by shrews is cricket, so crickets can be used as trapping bait or poison bait. The most consumed food after cricket are hongkong caterpillar (Tenebrio larvae), fish meatball, and cooked rice which can be used as alternative feeds or substitutes if crickets are not easy to find. Rodenticides containing zinc phosphide were more effective in killing shrews than poisons with the active ingredient coumatetralyl, with a relatively faster death time and less amount of feed required for feeding.

SUGGESTION

It is necessary to test feed preferences using other types of insects that are easier to find in nature. Acute and chronic rodenticides other than zinc phosphide and coumatetralyl can be further tested to determine their effectiveness.

REFERENCES

D. Aguilar-Miranda, E., G. López, M., Escamilla-Santana, C., & P. Barba de la Rosa, A. (2001). Characteristics of Maize Flour Tortilla Supplemented with Ground Tenebrio molitor Larvae. *Journal of Agricultural and Food Chemistry*, *50*(1), 192–195. https://doi.org/10.1021/jf010691y

Herawati, N. A., & Sudarmaji. (2009). Efikasi ekstrak biji jarak terhadap mortalitas tikus sawah. In *Prosiding Seminar Nasional Padi 2008* (pp. 511–519).

Kusmiyati, Noor, S. M., & Supar. (2005). Animal and human Leptospirosis in Indonesia. *Wartazoa*, *15*(4), 213–219.

Lim Boo Liat. (2015). The house rodents and house shrew in Malaysia and Southeast Asia. *Utar Agriculture Science Journal*, *1*(2), 43–50.

Lusiana Sinaga, C., Tobing, M., & Pinem, M. (2017). Uji Efikasi Rodentisida Nabati Daun Ruku-Ruku (Ocimum Sanctum L.) Terhadap Mortalitas Tikus Sawah (Rattus Argentiventer Robb & Kloss) Di Laboratorium. *Jurnal Agroekoteknologi Universitas Sumatera Utara*, *5*(2), 434–443.

Moniharapon, A. (2014). Teknologi Surimi dan Produk Olahannya. *Majalah Biam*, *10*(1), 16–30.

Panjaitan, I., Sofiana, A., & Priabudiman, Y. (2012). Suplementasi Tepung Jangkrik Sebagai Sumber Protein Pengaruhnya Terhadap Kinerja Burung Puyuh (Coturnix Coturnix Japonica). *Jurnal Ilmiah Ilmu-Ilmu Peternakan Universitas Jambi*, *XV*(1), 8–14.

Sholichah, Z., & Rahmawati, R. (2017). Distribution of pathogenic leptospira infection in rats and shrews in flood area of Pati district and endemic area of Boyolali district. *Balaba*, *13*(2), 173–182.

Shoma, S. F., Feeroz, M. M., & Hasan, M. K. (2016). Morphometry of Asian House Shrew (Suncus murinus) in Jahangirnagar University Campus. *Bangladesh Journal of Zoology*, *43*(2), 313–319. https://doi.org/10.3329/bjz.v43i2.27401

Syahputri, D. A. A., & Priyambodo, S. (2020). Flavor ingredients in the rodenticide formulation to improve consumption rate and mortality of house rat (Rattus tanezumi L.). *IOP Conference Series: Earth and Environmental Science*, *468*(1). https://doi.org/10.1088/1755-1315/468/1/012005

©2022 Swastiko Priyambodo, Rianita Septiana

Widiastuti, D., Pramestuti, N., Astuti, N. T., & Sari, T. F. (2016). Infeksi cacing Hymenolepis nana dan Hymenolepis diminuta pada tikus dan cecurut di area pemukiman Kabupaten Banyumas. *Vektora : Jurnal Vektor Dan Reservoir Penyakit*, *8*(2), 81–90. https://doi.org/10.22435/vk.v8i2.5319.81-90

Wiratno, Rizal, M., & Laba, I. W. (2011). Potensi ekstrak tanaman obat dan aromatik sebagai pengendali keong mas. *Bul. Littro*, *22*(1), 54–64.