



KNOCKDOWN TIME AND LETHAL TIME ON GERMAN COCKROACHES (*Blattella germanica* L.) AGAINST DELTAMETHRIN 5% INSECTICIDE

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ABSTRACT

German cockroaches are one of the household pests that are often found in Indonesia. German cockroach control generally uses insecticides such as deltamethrin. The absence of reports on the effectiveness of these insecticides in controlling German cockroaches in Indonesia, it is necessary to research the knockdown time 90% (KT₉₀) and lethal time 90% (LT₉₀) in German cockroaches from Bukittinggi (RMKN-BKT1) and Bandung (KRSA-BDG1). The results showed that 90% (KT₉₀) German cockroach knockdown time field strains of RMKN-BKT1 and KRSA-BDG1 were 23,189 minutes and 20,103 minutes, while the VCRU-WHO standard strain was 14,578 minutes. Lethal time 90% (LT₉₀) of German cockroaches in the field strains of RMKN-BKT1 and KRSA-BDG1 were 62,492 hours and 71,720 hours, while the standard VCRU-WHO strain was 59,045 hours. This study concludes that the German cockroach field strain has a longer paralysis and death time than the standard German cockroach strain. Thus, pest control management needs to increase monitoring and rotate insecticides.

KEYWORDS: German cockroaches, household pest, resistance.

INTRODUCTION

German cockroach (*Blattella germanica* L.) is a species of cockroach that is often found in Indonesia. These cockroaches can be found in various places such as settlements, restaurants and hotels (Sigit *et al.*, 2006). Cockroaches are also urban pests that carry various diseases and are medically detrimental (Shahraki *et al.*, 2013) and economically harmful. The use of insecticides is one of the actions that are often carried out by the community in controlling the population of German cockroaches. The use of the same insecticide and is used repeatedly can cause insects to be resistant to insecticides so that the controls performed become unsuccessful (Wu and Appel, 2017). The growing number of cases of resistance to German cockroaches has made the control more difficult in the field.

Deltamethrin is a synthetic pyrethroid class of insecticides that can be contact poison or stomach poison (Dietz *et al.*, 2009; Bhanu *et al.*, 2011). These insecticides are found in the market, especially in Indonesia. However, there have been no reports of the effectiveness or effectiveness of these insecticides in the control of German cockroaches in Indonesia, especially German cockroaches strains of Bukittinggi (RMKN-BKT1) and Bandung (KRSA-BDG1). Both cockroach

collection locations are tourist cities with high population mobilization and generally control of cockroaches there using insecticides. Therefore, this research needs to be done which aims to determine the knockdown time 90% (KT₉₀) and lethal time 90% (LT₉₀) in German cockroaches strains of RMKN-BKT1 and KRSA-BDG1. With this research, it will provide information that is very useful in controlling German cockroaches and the use of insecticides.

MATERIALS AND METHODS

Provision and Rearing *Blattella germanica* L. Cockroaches

This research was conducted at the Laboratory of Animal Physiology, Faculty of Mathematics and Natural Sciences, Andalas University. German cockroaches strain was collected from the cities of Bukittinggi (RMKN-BKT1) and Bandung (KRSA-BDG1) and reproduced in the laboratory. While the cockroaches used as a standard are laboratory strain/ standards from the Vector Control Research Unit (VCRU-WHO), School of Biological Sciences, Universiti Sains Malaysia, Penang, Malaysia (Figure 1). German cockroaches are maintained and propagated at room temperature between 25-28°C, relative humidity between 80-86% and photoperiod 12:12. German cockroaches are

given feed (pedigree) and water is replaced by ad libitum. The test cockroaches used were male adult

cockroaches released around 1-2 months (Rahayu, 2011; Rahayu *et al.*, 2012).

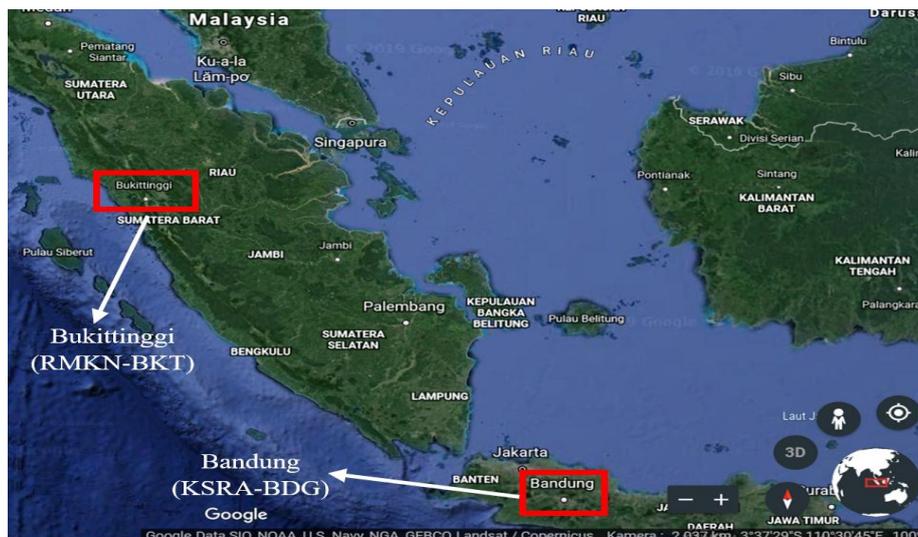


Figure 1: Location of extraction of German cockroaches in field strains from Bukittinggi (RMKN-BKT) and Bandung (KRSA-BDG) (Source: Google Earth, 2019).

Insecticide Bioassays on *Blattella germanica* L. Strain RMKN-BKT1 and KRSA BDG1

This test begins by taking each of 10 male adult cockroaches, then stunned with carbon dioxide for ± 30 seconds. Fainting cockroaches were dropped with 1 µL of insecticide with a concentration of 5% which was dissolved in acetone. Insecticides are applied with a micropipette on the ventral mesothorax (topical application) (Wu and Appel, 2017; Rahayu *et al.*, 2012). The treatment was carried out in five replications. After the treatment, the cockroach was kept in a 1L volume plastic box and given wet cotton and mixed (pedigree) feed. Cockroach death due to insecticide was observed at 72 hours after treatment.

Data Analysis of Knockdown Time 90% (KT₉₀) and Lethal Time 90% (LT₉₀) on *Blattella germanica* L. Strain RMKN-BKT1 and KRSA BDG1

The paralysis and mortality rates obtained from the treatment were analyzed probit using the Polo-PC program (LeOra software, 2004), so that knockdown time 90% (KT₉₀) and lethal time 90% (LT₉₀) were

obtained. The effectiveness criteria for insecticides are based on the Environmental Hygiene Efficacy Testing Method from the Directorate of Fertilizers and Pesticides (2004), namely the effectiveness of insecticides can be determined from the knockdown time 90% (KT₉₀) and lethal time 90% (LT₉₀) in certain periods. The effectiveness criteria for German cockroaches, namely knockdown time 90% (KT₉₀) must be achieved ≤20 minutes after exposure to insecticides and lethal time 90% (LT₉₀) must be achieved ≤6 hours after exposure to insecticides.

RESULTS

The knockdown Time 90% (KT₉₀) *Blattella germanica* L. Strain RMKN-BKT1 and KRSA BDG1 Against Deltamethrin Insecticide With a Concentration of 5%
The results of the knockdown time 90% (KT₉₀) showed that German cockroaches field strains of the Bukittinggi (RMKN-BKT1) and Bandung (KRSA-BDG1) took longer to knockdown than the German cockroach standard strain (VCRU-WHO) (Table 1.).

Table 1: Knockdown time of 90% (KT₉₀) of *Blattella germanica* L. against deltamethrin insecticide with a concentration of 5%.

Strain	N	KT ₉₀ (minute)	Slope ± SE	Criteria*
VCRU-WHO ^{S)}	50	14.578	3.808 ± 0.536	Effective
RMKN-BKT1 ^{R)}	50	23.189	5.092 ± 0.584	Ineffective
KRSA-BDG1 ^{R)}	50	20.103	3.996 ± 0.452	Effective

Information:

S = susceptible/ standard strain, R = field strain, N = the amount of German cockroaches used, KT₉₀ = the time needed to knockdown 90% of test animals, *Effective if KT₉₀ ≤ 20 minutes after exposure to insecticides according to DPP, 2004

The lethal Time 90% (LT₉₀) *Blattella germanica* L. Strain RMKN-BKT1 and KRSA BDG1 Against Deltamethrin Insecticide With a Concentration of 5%

The results of the lethal time 90% (LT₉₀) showed that German cockroaches field strains of the Bukittinggi

(RMKN-BKT1) and Bandung (KRSA-BDG1) took longer to lethal than the German cockroach standard strain (VCRU-WHO) (Table 2.)

Table 2: Lethal time of 90% (LT₉₀) of *Blattella germanica* L. against deltamethrin insecticide with a concentration of 5%.

Strain	N	LT ₉₀ (hours)	Slope ± SE	Criteria*
VCRU-WHO ^S)	50	59.045	2.532 ± 0.193	Ineffective
RMKN-BKT1 ^R)	50	62.492	4.415 ± 0.561	Ineffective
KRSA-BDG1 ^R)	50	71.720	3.361 ± 0.338	Ineffective

Information:

S = susceptible/ standard strain, R = field strain, N = the amount of German cockroaches used, LT₉₀ = the time needed to lethal 90% of test animals, * Effective if LT₉₀ ≤ 6 hours after exposure to insecticides according to DPP, 2004.

DISCUSSION

The knockdown time 90% (KT₉₀) or the time of paralysis achieved by the German cockroach VCRU-WHO standard strain is 14,578 minutes, while the field strains of RMKN-BKT1 and KRSA-BDG1 are respectively 23,189 minutes and 20,103 minutes. This showed that the 5% deltamethrin insecticide was effective in disabling German cockroach VCRU-WHO standard strains and KRSA-BDG1 field strains within ≤20 minutes after exposure to the deltamethrin insecticide. This is thought to occur because the given concentration is high enough to knockdown the German cockroach of the strain. Meanwhile, in the RMKN-BKT1 strain deltamethrin 5% insecticide was not effective for paralyzing German cockroaches within ≤20 minutes based on the criteria of the Directorate of Fertilizers and Pesticides (2004). The German cockroach strain of RMKN-BKT1 requires a concentration higher than 5% to be able to enter into the effective criteria. This can occur because the German cockroach strain RMKN-BKT1 is thought to have been frequently exposed to insecticides in the field, so it has been resistant to insecticides. The same was reported by Bestari (2014) that ByWS aerosol insecticides were made from cypermethrin and imiprothrin, MtWS insecticides made from esbiothrin, permethrin and imiprothrin and VpWS insecticides made from praletrine were not effective in paralyzing the German cockroach PLZ-PDG strain within ≤20 minutes. Madonna *et al.* (2015) also reported that MtWS aerosol insecticides made from esbiothrin, permethrin and imiprothrin were not effective in disabling German cockroaches of the GFA-JKT and PLZ-PDG strains. Also, RdWS insecticides made from transluthrin and cyfluthrin were also ineffective in paralyzing the German cockroach PLZ-PDG strain. German cockroach resistance cases against deltamethrin insecticides were also reported in Singapore (Ru and Chow, 2010), Nigeria (Kemabonta *et al.*, 2014), South Korea (Jang and Chang, 2017) and Argentina (Mengoni and Alzogaray, 2018).

German cockroaches can develop a mechanism of resistance in the body such as a mechanism of resistance

in behavior and physiology. Insects that can avoid the pressure of insecticides are a form of behavior resistance mechanisms (Lee, 1997). Meanwhile, physiological resistance can be caused by a decrease in the penetration rate of insecticides through the skin due to the thickening of the cuticle (Brogdon and McAllister, 1998). The mechanism of physiological resistance can also occur with increasing detoxification metabolic in the insect body due to increased detoxification enzyme activity against insecticidal molecules such as esterase enzymes and oxidase enzymes (Siegfried and Scoot, 1992). The mechanism of resistance that is also often found is the decrease in target cell sensitivity to insecticides due to gene mutations called knockdown resistance (kdr) (Dong *et al.*, 1998). The resistance that occurs due to genetic mutations that cause insects to adapt for the better. This increases the ability of insects to survive exposure to insecticides (IRAC, 2011). Resistant insects will be difficult to control even with repeated application and high use of doses or concentrations (Mantolu *et al.*, 2016). If resistance to insecticides has occurred, it will result in the ineffective use of insecticides to control German cockroach pests.

The lethal time 90% (LT₉₀) or the time of death achieved by the German cockroach VCRU-WHO standard strain is 59,045 hours, while the field strains of RMKN-BKT1 and KRSA-BDG1 are 62,492 hours and 71,720 hours respectively. It can be seen that the 5% deltamethrin insecticide gave was not effective in killing standard and field German cockroaches within ≤6 hours. Deltamethrin with a concentration of 5% used is thought to be still low, so it is not able to provide a rapid lethal effect on German cockroaches. To lethal 90% of German cockroaches within ≤6 hours, higher concentrations are needed. Bestari *et al.* (2014) also reported that aerosol insecticides made from active sipemethrin, imiprothrin, cypermethrin, imiprothrin, prallethrin, d-alethrin, esbiothrin, permethrin, transluthrin, cyfluthrin and praletrine were not effective in killing German cockroaches GFA-JKT and PLZ-PDG strains within ≤6 hours. The same thing was reported by Madonna *et al.* (2015) that aerosol insecticides not effective in killing

German cockroaches of the GFA-JKT and PLZ-PDG strains.

The time needed to lethal German cockroaches using deltamethrin 5% insecticide in the field strain is longer than the standard strain. This can be caused by differences in the speed of response of each German cockroach population that is vulnerable to being resistant or resistant. According to Hadayya and Jayanti (2012), there are differences in the speed of decomposition of insecticides in insects that are susceptible to resistance or resistance. This difference is in the way of transporting insecticides to important body parts (target sites) in insects. The level of selection pressure received by an insect population is one of the factors that influence the rate of development of resistance. With the finding of knockdown time 90% (KT₉₀) and lethal time 90% (LT₉₀) on German cockroaches strains of RMKN-BKT1 and KRSA-BDG1, insecticide rotations were needed to control the German cockroach strain. Insecticide rotation can be done using insecticides that have different target sites than deltamethrin insecticides. Also, control of German cockroaches can also use bioinsecticides that are environmentally friendly with integrated pest control techniques. This research is continuing to date on various other concentrations to see the effectiveness of deltamethrin insecticides in controlling German cockroaches.

CONCLUSION

Knockdown time 90% (KT₉₀) of German cockroach field strain of the RMKN-BKT1 and KRSA-BDG1 against deltamethrin 5% insecticide were 23,199 minutes and 20,103 minutes longer than the VCRU-WHO standard strain of 14,578 minutes. The lethal time 90% (LT₉₀) of German cockroach field strain of the RMKN-BKT1 and KRSA-BDG1 against deltamethrin 5% insecticide were 62,492 hours and 71,720 hours longer than the VCRU-WHO standard strain of 59,045 hours.

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