CATRINA (2015), 11 (1): 1-7

Efficacy of certain Gel Baits against the German cockroach, *Blattella germanica* L. (Dictyoptera: Blattellidae) under laboratory conditions

Olfat M. El-Monairy*, Yasser A. El-Sayed, Maysa Hegazy
Entomology Department, Faculty of Science, Benha University

ABSTRACT

The comparative attractivity and toxicity of certain Gel Baits against the German cockroach were investigated under laboratory conditions. The latter used to determine which of these baits were most effective against adult males and females German cockroach *Blattella germanica* (L.) (Dictyoptera: Blattellidae). The toxic baits tested were: Combat, 0.01% Fipronil; Siko Biko; Siko Biko with Taro plant; Hexan Gel and Killer Sweet, 47% boric acid. Results showed that in both choice and no-choice tests, Combat and Siko Biko with Taro plant were the most toxic baits against both sexes, while Killer sweet was the least toxic. In trapping experiments, Combat and Siko Biko with extract were also the most attractive to both sexes, while Killer sweet was the least attractive one. To improve the toxicity and attractiveness of Siko Biko bait, 4% ethanol extract of taro plant, *Colocasia esculenta* was added. The additive significantly rendered its toxicity from 83.33 ± 1.76% to 100% and from 60.00 ± 1.15% to 73.33±0.33% for males and females cockroach in no-choice assay, and from 76.66±0.88% to 100% and 53.33±0.88% to 66.66±1.01% for male and female cockroaches in choice assay, respectively. Its attractiveness was also increased from 36.66% to 80% and from 26.66% to 68.66% for male and female cockroaches, respectively.

INTRODUCTION

The German cockroach, *Blattella germanica* (L.), is an important urban insect pest. It is potential mechanical vector of many pathogens, including bacteria, helminthes, protozoans, and viruses. Accidental ingestion or inhalation of their fecal materials and saliva may trigger allergies and asthma (Lee and Ng 2009). To manage this pest, chemical treatment remains the most effective method. However, heavy reliance on insecticide treatments and high frequency of use have led to the development of resistance to various classes of insecticide, including chlorinated hydrocarbons, organophosphates, carbamates, pyrethroids (Lee and Lee, 2004 and Moemenbellah-Fard *et al*., 2013) , phenylpyrazoles (Holbrook *et al*., 2003, Kristensen *et al*., 2005; Gondhalekar and Scharf, 2012), and oxidiazines (Chai and Lee, 2010).

Insecticides resistance in *B. germanica* has become a major problem for the pest management industry. Fipronil, a phenylpyrazole insecticide, has been widely used against insecticide resistant strains of German cockroaches in laboratory experiments, especially in the form of gel bait (Nasirian, 2007).

Also, fipronil gel baits are highly effective in field German cockroach infested dwellings where control with other insecticides failed because of resistance (Nasirian, 2008). Raufer (2003) found that dust boric acid, and baits gels containing boric acid are effective in killing German cockroaches. Boric acid dust is an effective, inexpensive, and low risk (to animal and human health, and the environment), (Zurek *et al*., 2003). Zurek *et al*., (2002) studied the synergism between *Metarhizium anisopliae* and boric acid against German cockroach. *M. anisopliae* killed cockroaches significantly faster than without boric acid. Tabaru and Mochizuki (2005) found that the herbs, anise (*Pimpinella anisum*), sansyo (*Zathoxylum piperitum*), onion (*Allium cepa*), vanilla (*Vanilla planifolia*), mustard (*Brassica hirta*) and eucalypt (*Eucalyptus radiata*), have an attractive effect to the German cockroach. Xiaoyan *et al*., (2010) reviewed that soyabean powder and bananas had strong attractiveness for *B. germanica* and bananas can be used to produce the most effective toxic bait when it was combined with deltamethrin or Phoxim. Consequently, the aim of this study is to compare the efficiency of certain baits, improve the effectiveness and attractiveness of baits against *B. germanica.*

MATERIALS AND METHODS

laboratory rearing of *Blatella germanica*

Cockroaches were collected from dark and damp places like drains. The required species i.e. *Blatella germanica* was separated. The cockroaches were reared in laboratory of the Entomology Department, Faculty of Science, Benha University under laboratory conditions at temperature and humidity (27 ± 2 ˚ and 65 ± 5% RH). The insects were provided with white bread as food and water (pieces of cotton soaked with water, Durier and Rivault, 2000). A wooden frames (50 × 30 × 30 cm) (with a glass upper side) covered with muslin were used as rearing containers. Each container was provided with corrugated papers for shelter. The cages were cleaned weakly.

Tested baits

Five baits were tested; three bait products were purchased from a local distribution, one from USA and New product.

Descriptive informations on the tested baits:

Since the exact content of commercial baits formulations is not known, with the exception of the

* *Corresponding author: olfatelmonairy@gmail.com*

Table (1): Descriptive information on the tested baits.

Bait	Manufacturer	Active ingredient
Combat	USA.	0.01% Fibronil.
Killer Sweet	Al-Saied company, Egypt.	47% boric acid.
Hexan- gel	Aemekem Company for Import and Trade (LLC) in favor of Sharif Company for Medical Devices.	100% natural components.
Siko Biko	Top Bottling Company and detergent trade. (Siko Biko). Kilo 22 - Egypt Alex Agricultural Road - Sndion - Qalioub – Qalioubia.	Unknown.
New product		Siko Biko+4% taro plant leaves extract

active ingredient in combat bait, it was not possible to evaluate their ingredients separately; for this reason The performance of gel baits were evaluated against cockroach in a choice and no-choice assay (Table 1).

Efficacy trials (Toxicity)

Efficacy trials were conducted according to a modified method of (Wang *et al*., 2004) in conditions that were the same as rearing. Glass arenas (45 × 25 × 25 cm), with upper side screened with perforated plastic sheet to avoid insect escaping were used. Sixty adults from both male and female of *Blatella germanica* cockroaches were treated in separated arenas (20 insect/ arena). Cockroaches were starved and acclimated in the arenas for one day before bait introduced to arena and a harborage made of a piece of cardboard egg carton at the opposite end. To ensure that introduced cockroaches would remain in this shelters rather than aggregation elsewhere in the arena the egg carton was placed in the cockroach colony for 7 days, a procedure that results in the deposition of aggregation pheromone on the egg carton (Buczkowski *et al*., 2001). After the acclimation period, two bioassay techniques were accomplished:

Choice experiments:

One gram of bait was placed on a glass slide and introduced at the arena side opposite the harborage. Each arena also received one gram of white bread as food. The control arena was provided with white bread only. Three replicates were carried out for each bait product and for each sex. The mortality of the tested cockroaches was recorded daily for 7 days. Cockroaches were considered dead if they could not run away when flipped over with a pair of forceps.

No-choice experiment:

This assay was conducted as the previous one but without adding the food in the tested arenas.

Attractiveness of tested baits (Trap catch)

Attractiveness was conducted according to the method of (Anaclerio and Molinari, 2012). Glass arenas (45 × 25 × 25 cm), with upper side screened with perforated plastic sheet to avoid insect escaping were used to estimate the attractiveness of the tested baits. Two shelters made of cardboard egg carton were placed in two opposite corners inside each arena, and insects were left 24 hours in the arena for starvation and adaptation before the bioassay was carried out.

To verify the attractively of the bait, a drop (~0.2 gm) was placed on a glass slide cover and introduced in the middle of a cardboard sticky trap (7.5 × 7.5 cm cardboard covered with mouse and rat glue) located in the centre of the arena. An empty sticky trap was used as control in separated replicates (in each bioassay, only one sticky trap was put in the arena). The assessment of the catches was carried out after 1, 2, 3, 4 and 5 days, and caught insects were left inside the trap.

Three replicates were carried out for each bait product and for each sex (20 individuals /arena) in the same conditions as rearing.

Preparation of Taro plant leaves extract:

The leaves of taro plant *Colocacia esculenta* were washed with tap water and dried at room temperature for 3 weeks and ground in an electric mill. Two-hundred grams of the ground powder were taken and put inside one liter flask and the solvent (ethanol) was added and left for 72 hr. The flasks were shaken for 30 min. in a shaker then filtered. After that the solvent was evaporated in room temperature. 4% of the crud extract was added to Siko Biko bait to improve both of its toxicity and attractiveness against German cockroach.

Statistical analysis

Data were subjected to one way ANOVA test using SPSS program version 21, the values of mean mortality percentage and their stander error (SE) were calculated. Moreover, the obtained results were analyzed according to the method adopted by Finney (1971) to determine the LT_{50}, correlation coefficient (r) and slope.

RESULTS AND DISCUSSION

Comparative attractiveness of baits:

Results of daily percent trap catch of the tested baits were illustrated in Tables 2 & 3. All the products were

significantly different at p< 0.01 from the control. The females were less attractive than males. Nalyanya *et al*. (2001) evaluated the attractiveness of several insecticide bait formulations contained boric acid, to German cockroaches and showed that nymphs were as responsive as males whereas females were less

Table (2): Attractiveness of different bait products to males of *B. germanica* during investigated period.

Product	% Trap catch ± SE				
	1st Day	2nd Day	3rd Day	4th Day	5th Day
Combat	18.33 ± 0.66^{a}	36.66 ± 0.66^{a}	48.32 ± 0.66^{ab}	58.32 ± 0.00^{ab}	68.32 ± 0.57^{a}
Siko Biko + extract	26.66 ± 0.33^{b}	50.0 ± 0.88^{a}	66.66 ± 0.33^{a}	75.0 ± 0.88^{ac}	80.0 ± 0.57^{ab}
Siko Biko	11.66 ± 0.33^{c}	16.66 ± 0.57^{bd}	26.66 ± 0.00^{b}	29.99 ± 0.33^{cd}	36.65 ± 0.66^{a}
Hexan gel	11.66 ± 0.33^{c}	24.99 ± 0.33^{bc}	26.65 ± 0.33^{c}	33.31 ± 0.33^{a}	33.31 ± 0.00^{b}
Killer Sweet	8.33 ± 0.33^{c}	9.99 ± 0.33^{d}	19.99 ± 0.57^{b}	26.65 ± 0.33^{a}	26.65 ± 0.00^{b}
control	-	-	1.66 ± 0.33^{c}	1.66 ±0.00^{cd}	5.0 ± 0.00^{ab}

N= 3 replicates for each treatment, percent attractivity in the same column followed by the same superscript (a, b, c or d) are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$

Table (3): Attractiveness of different bait products to females of *B. germanica* during investigated period.

Product	% Trap catch ± SE				
	1st Day	2nd Day	3rd Day	4th Day	5th Day
Combat	6.66 ± 0.57^{b}	23.33 ± 0.33^{a}	33.32 ± 0.00^{ab}	41.65 ± 0.33^{ac}	58.31 ± 0.66^{a}
Siko Biko + extract	21.66 ± 0.57^{a}	36.66 ± 0.57^{a}	50 ± 0.88^{a}	60.0 ± 0.57^{a}	66.66 ± 0.33^{b}
Siko Biko	11.66± 0.66^{b}	18.32 ± 0.33^{b}	26.65 ± 0.33^{ad}	26.65 ± 0.00^{bd}	26.65 ± 0.00^{cd}
Hexan gel	8.33 ± 0.00^{b}	9.99 ± 0.33^{c}	13.32 ± 0.33^{cd}	16.65 ± 0.66^{bc}	18.31 ± 0.33^{bd}
Killer Sweet	-	6.66 ± 0.33^{b}	11.66 ± 0.00^{bcd}	13.33 ± 0.33^{bd}	15 ± 0.33^{bd}
Control	-	-	-	1.65 ± 0.33^{bd}	1.65 ± 0.00^{cd}

N= 3 replicates for each treatment, percent attractivity in the same column followed by the same superscript (a, b, c or d) are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$

responsive. Also, the results showed that the additives (4% of taro plant leaves extract) to Siko Biko bait significantly increase its attractiveness to both sexes than other baits.

The percent attractiveness for the new product (Siko Biko + extract) after five days was 68.66% for females and 80% for males followed by Combat (58.31% and 68.32%); Siko Biko (26.65% and 36.65%); Hexan gel (18.31% and 33.31%) and Killer Sweet (15% and 26.66%) for females and males, respectively. These results are in good agreement with Tabaru and Mochizuki (2005) and Xiaoyan *et al*. (2010).

It is also comparable to the results presented by Zhikuan *et al*., (2008) where the *B. germanica* consumed baits consisting of AB attractant by 65.35%-97.17% more than the baits without the attractant. This was also demonstrated by Zurek *et al.* (2002) who showed that there was a synergistic interaction between boric acid and *Metarhizium anisopliae* and in combination with boric acid (topically applied as a dust or in drinking water), *M. anisopliae* killed cockroaches significantly faster than without boric acid. The results of Malik *et al.,* (2012) showed synergism action when *Bacillus thuringiensis* was combined with boric acid, cypermethrin and powder of neem leaves against *Tribolium castaneum*

Comparative Efficacy of baits

A) Choice assay:

The data summarized in Tables (4 & 5) indicated that mortality percentage of males and females cockroach were increased as the exposure time to baits was increased. Seven days after exposure, mortality percentage was significantly the greatest for Combat (100%) for both sexes. The same results were obtained by Nasirian (2010) who showed that mortality of German cockroach was100% after 6 days of ingestion of fibronil. Agrawal *et al.,* (2010) resulted from a field study that single application of fipronil gel bait was able to reduce German cockroach infestation up to 96.8% at the end of 12 weeks of application. Hanii *et al.,* (2006) found that the reduction rates of German cockroaches by applying fipronil baits were 90.9% at Korean restaurants, 96.4% at Chinese restaurants, and 89.4% in beer hall kitchens after 4 weeks of the treatment.The obtained results also showed that combat had the lowest LT_{50} (0.96 and 1.55 days for males and females, respectively). Snoddy andAppel (2014) reported similar findings with Asian cockroach, *Blattella asahinai.* They resulted that fipronil granules were significantly more toxic than the essential oil, emulsifiable concentrate, (EC) formulation under laboratory assay, with LT_{50} values of 0.45day and reduced populations by 100% at 30 days after treatment in field study. The second potent bait was Siko Biko + extract (100% for males and 66.66% for females). So this additive increased the efficacy of Siko Biko bait against both males and

females, cockroach .The potent effect of Taro leaves extract may be related to toxic chemical content. Mainly leaves contain calcium oxalate, fibers, minerals

Table (4): Efficacy trials (Toxicity) of different bait products against males of *B. germanica* through seven days in choice experiment.

Product	% Mortality ± SE							LT_{50} (Days)	Slop	r
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			
Combat	56.66± 2.9^{a}	93.33 ± 1.33^{a}	96.66 ± 0.66^{a}	100 ± 0.00^{a}	100 ± 0.00^{a}	100 ± 0.00^{a}	100 ± 0.00^{a}	0.96	4.46	0.94
Siko Biko + extract	33.33± 0.66^{b}	58.33 ± 0.33^{b}	88.33 ± 1.20^{a}	100 ± 0.00^{a}	100 ± 0.00^{a}	100 ± 0.00^{b}	100 ± 0.00^{a}	1.48	5.37	0.807
Siko Biko	3.33 ± 0.66^{c}	20.0 ± 1.15^{c}	40.0 ± 1.15^{b}	56.66 ± 0.66^{b}	66.66 ± 1.33^{b}	73.33 ± 1.76^{c}	76.66 ± 2.4^{ab}	3.8	3.1	0.994
Hexan gel	-	6.66 ± 0.66^{cd}	20.0 ± 2.00^{c}	43.33 ± 2.40^{b}	43.33 ± 2.40^{c}	60.0± 2.30^{c}	60.0 ± 2.30^{b}	5.6	3.47	0.95
Killer Sweet	6.66 ± 0.66^{c}	10.0± 1.76^{cd}	21.66 ± 1.45^{bc}	36.66± 2.33^{b}	46.66± 2.18^{bc}	56.66 ± 2.02^{c}	56.66 ± 2.02^{b}	5.63	2.33	0.96
Control	-	-	-	-	-	-	-			

N= 3 replicates for each treatment, percentage mortality in the same column followed by the same superscript are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$

Table (5): Efficacy trials (Toxicity) of different bait products against females of *B. germanica* through seven days in choice experiment.

Product	% Mortality ± SE							LT_{50} (Days)	Slop	r
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			
Combat	36.66 ± 2.40^{a}	66.66± 2.40^{a}	75.0 ± 2.08^{a}	80.0 ± 2.30^{a}	83.33± 1.76^{a}	100± 0.00^{a}	100 ± 0.00^{a}	1.55	3.26	0.66
Siko Biko +extract	15± 0.57^{b}	36.66± 0.33^{b}	55.0 ± 1.15^{b}	63.33 ± 1.45^{a}	65.0 ± 1.53^{a}	65.0 ± 1.53^{b}	66.66 ± 1.20^{b}	2.88	1.78	0.93
Siko Biko	-	3.33± 0.66^{c}	20.0 ± 0.00^{c}	33.33 ± 0.66^{b}	36.66 ± 2.00^{b}	43.33 ± 1.33^{c}	53.33 ± 2.40^{b}	6.33	3.28	0.94
Hexan gel	3.33± 0.66^{b}	3.33± 0.66^{c}	16.66 ± 1.76^{cd}	30.0 ± 1.53^{b}	36.66 ± 0.88^{b}	51.66 ± 0.33^{c}	51.66 ± 0.33^{b}	6.62	2.58	0.91
Killer Sweet	3.33± 0.66^{b}	6.66± 0.66^{c}	20.0 ± 1.15^{c}	36.66 ± 1.20^{b}	36.66 ± 1.20^{b}	43.33 ± 1.85^{c}	46.66 ± 2.33^{b}	7.42	2.28	0.95
Control	-	-	-	-	-	-	-			

N= 3 replicates for each treatment, percentage mortality in the same column followed by the same superscript are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$

(calcium, phosphorus, etc.), and starch, vitamin A, B, C, etc. (Sheth 2005) phytochemically, these also contain alkaloid, saponins, steroid, tannins, flavones, apigenin, luteolin and anthocyanins (Judee *et al*., 2012). Then all other baits have the efficacy in descending order.

B) No-choice assay:

Table (6 & 7) showed the percentage mortalities and LT_{50} for each bait to males and females. The results were the same as in choice assay.

Combat and the new product were the only baits able to produce 100% mortality for males in less than five days and only Combat gave 100% mortality of females in the sixth day which as the same results obtained by Nasirian (2010). Results in choice and no-choice assay showed that percentage mortalities were higher in no-choice assay for all baits and for both sexes and the adult males were at least twice more susceptible than the adult females. This may be due to female cockroaches having higher mass than males due to differential lipid content and thus affecting insecticide toxicity (Lee *et. al*., 1996). The same results were obtained by Koehler *et. al*., (1993) who found that susceptible adult males were approximately two times more susceptible than the females when tested with bendiocarb, chlorpyrifos and cypermethrin.

CONCLUSION

From the previous results, we concluded that the addition of 4% of the crud leaves extract of taro plant to Siko Biko bait increase the attractiveness which led the insect to consume much amount of bait than Siko Biko bait alone**.** This potent new product that significantly increase the mortality in both choice and no-choice assay for both sexes were recommended to use rather than other commercial baits in Egypt.

Table (6): Efficacy trials (Toxicity) of different bait products against males of *B. germanica* through 7 days in no choice experiment.

Product	% Mortality ± SE							LT_{50} (Days)	Slop	r
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			
Combat	83.33±0.33[a]	± 100 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]	100 ± 0.00[a]	0.64	7.08	1
Siko Biko + extract	38.33 ±0.66[b]	±81.6 0.88[b]	±98.3 0.33[a]	100 0.0±[a]	± 100 0.0[a]	100 ±0.0[a]	100 ± 0.00[a]	1.2	5.58	0.97
Siko Biko	23.33 ±0.33[c]	±53.3 0.66[c]	±71.6 1.20[b]	±71.6 1.20[b]	±73.3 1.33[b]	± 80.0 1.15[b]	± 83.3 1.76[b]	1.86	1.88	0.94
Hexan gel	11.66 ±0.66[d]	31.7 ± 1.20[d]	± 50.0 0.57[c]	±61.7 0.66[b]	±73.3 1.45[b]	76.66 ± 0.88[b]	78.3 ±0.66[b]	3	2.45	0.99
Killer Sweet	15 ±0.57[d]	40 ± 2.0[cd]	56.7± 1.6[c]	60 ±2.0[b]	±63.3 2.4[b]	73.33 ± 1.76[b]	76.7 ± 1.33	2.88	2.47	0.98
Control	-	-	-	-	-	-	-			

N= 3 replicates for each treatment, percentage mortality in the same column followed by the same superscript are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$

Table (7): Efficacy trials (Toxicity) of different bait products against females of *B. germanica* through 7 days in no choice experiment.

Product	% Mortality ± SE							LT_{50} (Days)	Slop	r
	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day			
Combat	73.33 ± 1.33[a]	95.00 ± 0.00[a]	96.66 ± 0.33[a]	96.66 ± 0.33	98.33 ± 0.33[a]	100 ± 0.33[a]	100 ± 0.00[a]	0.56	2.48	0.77
Siko Biko + extract	5.00 ± 0.57[b]	26.66 ± 0.57[b]	41.66 ± 0.33[b]	56.66 ± 0.66[b]	65.00 ± 0.0[b]	70.00 ±0.5[b]	73.33 ± 0.33[b]	3.63	2.68	0.99
Siko Biko	3.33 ± 0.33[b]	6.66 ± 0.66[c]	16.66 ± 0.66[c]	21.66 ± 0.33[c]	26.66 ± 0.66[c]	50.0± 0.00[b]	60.00 ± 1.15[b]	6.03	2.43	0.92
Hexan gel	5.00 ± 0.57[b]	10.00 ± 1.15[c]	16.66 ± 1.76[c]	18.33 ± 2.02[c]	28.33 ± 1.85[c]	41.6± 2.18[b]	56.66± 2.03[b]	6.78	1.96	0.89
Killer Sweet	3.33 ± 0.66[b]	10.00 ± 2.0[c]	16.66 ± 3.33[c]	21.66 ± 3.84[c]	26.66 ± 4.37[c]	43.3± 4.05[b]	50.0 ± 3.46[b]	7.04	2.1	0.96
Control	-	-	-	-	-	-	-			

N= 3 replicates for each treatment, percentage mortality in the same column followed by the same superscript are not significantly different (ANOVA) followed by Duncans test, $p < 0.01$.

REFERENCES

AGRAWAL, V. K., A. AGARWAL, V. CHOUDHARY, R. SINGH, N. AHMED, M. SHARMA, K. KUSUM NARULAB, AND P. AGRAWAL. 2010. Efficacy of imidacloprid and fipronil gels over synthetic pyrethroid and propoxur aerosols in control of German cockroaches (Dictyoptera: Blatellidae). Journal of Vector Borne Dis **47:** 39-44.

ANACLERIO, M., AND F. MOLINARI. 2012. Intra and inter-specific attraction of cockroach faecal extracts: studies for improving bait activity**.** Bulletin of Insectology **65** (1): 113-118.

BUCZKOWSKI G., J. R. J. KOPANIC, AND C. SCHAL. 2001. Transfer of ingested insecticides among cockroaches: Effects of active ingredient, bait formulation, and assay procedures. Journal of Economic Entomology **94**(5): 1229-1236.

CHAI, R. Y., AND C. Y. LEE, 2010. Insecticide resistance profiles and synergism in field populations of the German cockroach (Dictyoptera: Blattellidae) from Singapore. Journal of Economic Entomology **103:** 460-471.

DURIER, V., AND C. RIVAULT. 2000. Comparisons of toxic baits for controlling the cockroach, *Blattella germanica*: attractiveness and feeding stimulation. Medical and Veterinary Entomology **14**(4): 410-418.

FINNEY D. J. 1971. Probit analysis. Cambridge University Press, London, pp 68-78

GONDHALEKAR, A. D., AND M. E. SCHARF. 2012. Mechanisms underlying fipronil resistance in a multiresistant field strain of the German cockroach

(Blattodea: Blattellidae). Journal of Medical Entomology **49:** 122-131.

HANII, R., L. INYONG, J. SOUNGHOO, AND Y. YONG TAISOON 2006. Field trial on the control effect of fipronil bait against German cockroaches. Korean Journal of Parasitology **44** (3): 255-257.

HOLBROOK, G. L., J. ROEBUCK, C. B. MOORE, M. G. WALDVOGEL, AND C. SCHAL. 2003. Origin and extent of resistance to fipronil in the German cockroach, *Blattella germanica* (L.) (Dictyoptera: Blattellidae). Journal of Economic Entomology **96:** 1548-1558.

JUDEE N. NOGODULA, JESSA MARIE D. DRAUG, MARYJANE S. JAMERO AND CHARMAINE LEI E. SUYOM 2012. Phytochemical and antibacterial action of taro (*Colocasia esculenta*) (Araceae) aqueous-ethanolic leaf extract against selected bacterial strains. UIC Research journal **18** (1):221-236

KOEHLER, P. G., C. A. STRONG, R. S. PATTERSON, AND S. M. VALLES. 1993. Differential susceptibility of German cockroach (Dictyoptera: Blattellidae) sexes and nymphal age classes to insecticides. Journal of Economic Entomology **68:** 785-792.

KRISTENSEN, M. K. K. HANSEN, AND K. M. V. JENSEN. 2005. Cross- resistance between dieldrin and fipronil in German cockroach, *Blattella germanica* (Dictyoptera: Blattellidae). Journal of Economic Entomology **98:** 1305-1310.

LEE, C. Y., H. H. YAP, AND N. L. CHONG. 1996. Insecticide toxicity on the adult German cockroach, *Blattella germanica* (L.) (Dictyoptera: Blattellidae). Malaysian Journal of Science **17**(A): 1-9.

LEE, L. C., AND C. Y. LEE. 2004. Insecticide resistance profiles and possible underlying mechanisms in German cockroaches, *Blattella germanica* (Linnaeus) (Dictyoptera: Blattellidae) from Peninsular Malaysia. Med. Entomol. Zool. **55:** 77-93.

LEE, C. Y., AND L. C. NG. 2009. Public health importance of cockroaches. In C. Y. Lee and L. C. Ng (eds.). Pest cockroaches of Singapore: a scientific guide for pest management professionals. Pest Management Association, Singapore. 15-18.

MALIK, K., S. NAZIR, A. FAROOQ, F. JABEEN, ANDLEEB, AND T. M. ALI. 2012. Study on the combined insecticidal effect of pyrethroid, *Azadirachta indica* and boric acid on the *Bacillus thuringiensis* efficacy in *Tribolium castaneum.* African Journal of Microbiology Research **6** (27): 5574-5581.

MOEMENBELLAH-FARD, D. F., M. R. FAKOORZIBA, K. AZIZI, AND M. MOHEBBI-NODEZH. 2013. Carbamate Insecticides Resistance Monitoring of Adult Male German Cockroaches, *Blattella germanica* (L.), in Southern Iran. Journalof Health Science Surveillance **1**(1): 41-47.

NALYANYA, G., D. S. LIANG, R. J. JR. KOPANIC, AND C. SCHAL. 2001. Attractiveness of insecticide baits for cockroach control (Dictyoptera: Blattellidae): laboratory and field studies. Journal of Economic Entomology **94**(3): 686-693.

NASIRIAN, H. 2007. Duration of fipronil and imidacloprid gel baits toxicity against *Blattella germanica* strains of Iran. Iranian Journal of Arthropod-Borne Diseases **1**(2): 40-47.

NASIRIAN, H. 2008. Rapid elimination of German cockroach, *Blatella germanica*, by fipronil and imidacloprid gel baits. Iranian Journal of Arthropod-Borne Diseases **2**(1): 37-43.

NASIRIAN, H. 2010. An overview of German cockroach, *Blattella germanica*, Studies Conducted in Iran. Pakistan Journal of Biological Science **13**(22): 1077 1084.

RAUFER, B. 2003. Stamping out cockroaches. Pork **23**(2): 26-27.

SHETH AK. 2005. The Herbs of Ayurveda Ahmedabad: A. K. Sheth publishers. 356.

SNODDY, T. E., AND G. A. APPEL. 2014. Field and Laboratory Efficacy of Three Insecticides for Population Management of the Asian Cockroach. Journal of Economic Entomology **107**(1):326-332.

TABARU, Y., AND K. MOCHIZUKI. 2005. Repellency of ethanol extracts of herbs to the German cockroach, *Blattella germanica* (Blattaria: Blattellidae), observed by feces distribution in the extract treated harborages. Medical Entomology and Zoology **56** (2): 139-143.

WANG, C. L. M. E. SCHARF, AND G. W. BENNETT. 2004. Behavioral and physiological resistance of the German cockroach to gel baits. Journal of Economic Entomology **97**(6): 2067-2072.

XIAOYAN, W. Z.AO, Y. HONG, AND Z. FUXING. 2010. Attractiveness of different foods for *Blattella germanica*. Chinese Journal of Vector Biology and Control **21**(2): 112-114.

ZHIKUAN, J. C. CHAO, AND H. ZHAOJIU. 2008. Efficacy of cockroach attractant on *Periplaneta americana* and *Blatella germanica*. Chinese Journal of hygienic Insecticides and Equipments **14**(5): 339-340.

ZUREK, L., W. D. WATSON, AND C. SCHAL. 2002. Synergism between *Metarhizium anisopliae* (Deuteromycota: Hyphomycetes) and Boric Acid against the German cockroach (Dictyoptera: Blattellidae). Journal of Biological control **3** (23): 296-302.

ZUREK, L., J. C. GORE, S. M.STRINGHAM, D. W. WATSON, M. G. WALDVOGEL, AND C. SCHAL. 2003. Boric acid dust as a component of an integrated cockroach management program in confined swine production. Journal of Economic Entomology **96**(4): 1362-1366.

قياس فاعلية وكفاءة بعض الطـــعوم السامة ضد الطور اليافع لحشرة الصرصور الألماني *Blattella germanica* تحت ظروف المختبر

الفت المنيري، ياسر السيد، مايسة حجازي
قســـم علم الحشـــرات – كليـــة العـــلوم – جامعة بنهـــا

الملخص العربي

تم مقارنة جاذبية وسمية بعض الطعوم السامة التجارية المختبرة: 0.01٪ فيبرونيل (Fibronil) وسيكو بيكو (Siko Biko) وسيكو بيكو مضاف إلى 4٪ من مستخلص أوراق نبات القلقاس (Siko Biko + 4% taro plant leaves extract) وهكسان جل (Hexan gel) والقاتل البارع مع حمض البوريك (Killer Sweet +47٪ boric acid) ضد الطور اليافع لحشرة الصرصور الألماني *Blattella germanica* تحت ظروف المختبر. وذلك لتحديد أي من هذه الطعوم هي الأكثر فاعلية ضد ذكور وإناث الصراصير. أظهرت النتائج أن كل من 0.01٪ فيبرونيل وسيكو بيكو مضاف إلى 4٪ من مستخلص نبات القلقاس هما أكثر الطعوم سمية ضد كلا الجنسين، في حين كان طعم ال قاتل البارع أقل سمية في كل التجارب. وكان أيضاً كل من 0.01٪ فيبرونيل وسيكو بيكو مضاف إلى 4٪ من مستخلص نبات القلقاس الطعمان الأكثر جاذبية لكلا الجنسين، في حين كان طعم ال قاتل البارع الأقل جاذبية. ولتحسين سمية وجاذبية طعم سيكو بيكو تم إضافت 4٪ من مستخلص أوراق نبات القلقاس *Colocasia esculenta*. هذه المادة المضافة زادت سمية الطعم من 83.33٪ الى 100 ٪ ومن60٪ إلى ٪ 73.33 للذكور والإناث فى تجربة عدم الإختيار على التوالي، ومن 76.66 ٪ الى 100٪ و 53.33٪ إلى 66.66٪ لذكور وإناث الصراصير فى تجربة الإختيار على التوالي. وزادت جاذبيته أيضا من 36.66 ٪ إلى 80 ٪ ومن 26.66٪ إلى 68.66٪ لذكور وإناث الصراصير على التوالي.