APPLIED ENTOMOLOGY AND INNOVATION (AEI)

VOLUME 1 ISSUE 1 (2024)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

Applied Entomology and Innovation (AEI)

Volume 1 Issue 1, Year 2024
https://journals.e-palli.com/home/index.php/aei

Influence of the Chili Pepper (*Capsicum annuum*) Extract on American Cockroach (*Periplaneta americana*)

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Article Information

Received: February 16, 2024
Accepted: March 11, 2024
Published: March 14, 2024

Keywords

Pest Management, Chili Pepper, American Cockroach, Concentration, Eco-Friendly Alternative

ABSTRACT

The increasing reliance on synthetic pesticides necessitates the exploration of eco-friendly alternatives. This study investigated the pesticide potential of chili pepper (*Capsicum annuum*) extract against American cockroaches (*Periplaneta americana*) using three concentrations: 50%, 75%, and 100%. Cockroaches were treated with five sprays per concentration and observed for 24 hours; the number of deaths and time elapsed were recorded. The result revealed the average death of the American Cockroach (*Periplaneta americana*) in the treatment with varying concentrations. The average death using 100% concentration of the Chili Pepper (*Capsicum annuum*) Extract is three kills out of 3 in all seven trials with an average time of 29.5 minutes. The 75% concentration has an average death of 2.4 with an average time of 50.7 minutes, and the 50% concentration has an average of 1.8 deaths within 83.1 minutes. The results of the ANOVA test imply that an increase in concentration level leads to an increase in the effectiveness of the pesticide potential of Chili pepper (*Capsicum annuum*) Extract. This study demonstrates the potential of chili extract as an organic pesticide, albeit with concentration-dependent efficacy and requiring further optimization and assessment of long-term environmental and health implications. It paves the way for exploring tabasco pepper extract as a sustainable and safer alternative for cockroach control, contributing to environmentally conscious pest management practices.

INTRODUCTION

Cockroaches living near humans pose a public health risk due to their capacity to contaminate food and surfaces. They can transport disease-causing microbes (pathogens) to food and areas where food is handled, potentially leading to foodborne illnesses. Cockroach body parts and debris contain allergens that can induce allergic reactions and asthma attacks in sensitized individuals (Gondhalekar *et al.*, 2021).

Capsaicin, the spicy component of the Capsicum genus, is typically extracted directly from the fruit. Increasing demand has led to exploring methods to boost production beyond simple extraction, which involves optimizing existing practices and characterizing the compound for better understanding (Reyes-Escogido *et al.*, 2011).

The pesticide properties of capsaicin and other capsaicinoids in the form of capsicum have recently been a promising area to study. Recent studies revealed that it is effective because of its synergistic effects against numerous insects such as beetles, budworms, cabbage loopers, etc. They are also effective when sprayed, especially as a solution or emulsion, as pesticides for cotton, soybeans, common garden vegetables, and flowers (Neumann, 2003).

This study explored the influence of the varying concentrations of chili pepper (*Capsicum annuum*) extract on American cockroaches (*Periplaneta americana*).

Specifically, it aimed to:

a. Determine the effects of the different concentration levels of the chili pepper extract on the American cockroach, and;

b. Find the significant difference among the varying concentrations of chili pepper extracts.

LITERATURE REVIEW

Threat Associated with Cockroaches

Cockroaches act as scavengers, consuming diverse food sources. This omnivorous di*et al*lows them to unwittingly carry and spread harmful viruses, bacteria, and protozoans to humans (Wannigama *et al.*, 2014). Cockroaches act as tiny disease taxis in environments like homes, hospitals, and factories, carrying fungi, viruses, bacteria, and parasites on their waste and bodies. Scientists have even isolated significant pathogens from these insects, highlighting their potential to spread illness in places where people live, work, and receive medical care (Kassiri *et al.*, 2014).

Akbari *et al.* (2015) used a combination of API kits, plating, and genetic analysis to identify bacteria in cockroach midguts. The API kit revealed 11 species, including some potentially helpful (*E. coli, Shigella flexineri, Citrobacter freundii*) and others likely short-term residents. However, conventional plating only found four isolates and three mismatched the API and genetic results. Ultimately, API and genetic analysis proved more reliable, accurately identifying three species (*Shigella flexineri, Citrobacter freundii, E. coli*). However, further investigation is needed to distinguish closely related species like *C. freundii* and *C. murliniae.*

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Potential of Capsicum Genus as Pesticides

A study was conducted to test the effectiveness of an alternative pesticide with capsaicin as its active ingredient against common farm pests, grasshoppers, caterpillars, and snails. The sample was tested at three capsaicin concentrations: low, average, and high. The study also tested the effectiveness of commercial insecticides against the same pests. The study found that the alternative pesticide effectively killed pests at all three capsaicin concentrations, but the high concentration was the most effective. Commercial pesticides effectively killed the pests, but alternative pesticides were more effective at high concentrations. The study also tested the alternative pesticide against ants and termites. The pesticide was effective in killing both pests. The study found that the alternative pesticide with capsaicin as its active ingredient is a promising alternative to commercial pesticides. It is effective against various pests and less environmentally harmful (Lacar, 2019). The natural and organic pesticides proved effective against spiders and cockroaches. It was evident because both types of insects died after being sprayed with the natural pesticide (Macahia, 2019).

On the other hand, the study by Gesim (2016) revealed that the chili pepper pod extract did not kill ants or cockroaches at any of the three concentrations tested. The ants and cockroaches were not killed but showed signs of distress, such as weakness. The study hypothesized that there would be no significant difference in the effectiveness of the chili pepper pod extract at different concentrations. This hypothesis was supported by the study results, which showed that the extract was ineffective at any concentration. The researcher recommends that future studies test higher chili pepper pod extract concentrations to see if it effectively kills ants and cockroaches at higher doses. The researcher also recommends that future studies test the extract on other types of pests to see if it is effective against a broader range of insects.

Research Paradigm

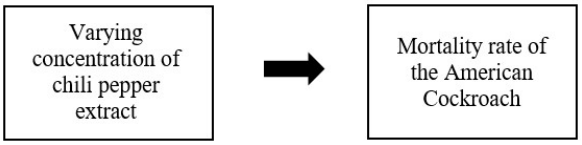

Figure 1: The diagram shows that the insecticide concentration directly influences its effectiveness against cockroaches. Higher concentrations increase cockroach mortality as the insecticide's active ingredients become more potent and overwhelm the cockroach's detoxification mechanisms.

Hypothesis

From the figure shown above, a null hypothesis was formulated:

H_0 = There is a varying effect on the cockroach in the different concentration levels.

MATERIALS AND METHODS

Research Design

This study utilized quantitative research, specifically experimental research design, to assess the effect of chili pepper extract in varying concentrations (50%, 75%, and 100%) on American cockroaches.

Study Area

The experimentation was conducted in the Science Laboratory of the Paramount School of Arts, Languages, Management, and Sciences, Incorporated, located on National Irrigation Authority Road, Purok-3, Bagontaas, Valencia City, Bukidnon, 8709, Philippines.

Collection and Identification of the Samples

The chili pepper (*Capsicum annuum*) is collected in the chili farm in Lantapan, Bukidnon. The sample was identified using the Catalogue of Seed Plants of the West Indies and confirmed by a botanist. The American cockroach is collected in the different households in Bangcud, Malaybalay City Bukidnon. The samples are identified using the Cockroach Control Manual of the Institute of Agriculture and Natural Resources: Nebraska Extension and confirmed by an entomologist. The cockroaches are captured carefully, preventing any stress that may affect measuring the samples' mortality rate. It was acclimated in the container for at least three days before the experimentation began.

Preparation of the Chili Pepper Extract

The stalk and leaves of the chili pepper were removed, leaving the fruit itself. The samples were chopped and dried using a dehydrator. The dried sample was ground until it was powdered. The Maceration method used ethanol for at least five days with frequent agitation until the soluble matter was dissolved. After, the liquid is strained off using gravity filtration to separate the solution and the undissolved powder. For further purification of the extract, it is subjected to low heat to remove the ethanol and retain the natural oil. Natural oil is used in formulating the different concentrations of the extract.

Data Analysis Method

One-way ANOVA is utilized to identify the significant difference among the varying concentrations of the chili pepper extract.

RESULTS AND DISCUSSION

Analysis on the Effectiveness of the Varying Concentration of Chili Pepper (*Capsicum annuum*) Extract on American Cockroach (*Periplaneta americana*)

Table 1 shows the average deaths of American cockroaches in seven trials after being sprayed with three different concentrations of chili extract. Per trial, it contains three cockroaches with five sprays and 24 hours of observation time. The experiment results reveal how effective the 100 % concentration of the extract is with 3 of our three kills per trial. The 75 % concentration has an

Table 1: Average Death of the American Cockroach (*Periplaneta americana*) in varying concentrations of Chili Pepper (*Capsicum annuum*) Extract

Concentration	Average Death	Average Time	Log_{10} Concentration	Mortality Rate
50 % Chili Pepper Extract, 50 % Distilled Water	1.8	83.1 min	5.70	60 %
75 % Chili Pepper Extract, 25 % Distilled Water	2.4	50.7 min	5.88	80 %
100 % Chili Pepper Extract	3	29.5 min	6.00	100 %

average kill of 2.4, and 50 %, which has an average of 1.8 deaths. The study implies that an increased concentration of Chili extract (*Capsicum annuum*) leads to an increase in the effectiveness of the pesticide potential of chili pepper extract.

In the study conducted by Lawan *et al.* (2016), increased chili extract concentration proved effective in killing insects. The experiment utilized 10 %, 20 %, and 30 % concentrations of the chili pepper fruit extract on the Diamondback moth (*Plutella xylostella L.*) Caterpillar infestation. The experiments reveal that the 30 % concentration of the chili extract effectively reduces the population of *P. xylostella* compared to the lower concentration used in the study.

In a similar study conducted using chili extract on flies, increasing concentration content provides promising results on the flies and cockroaches as repellants and insecticides. The results also revealed that using organic alternatives to commercial insecticides is safer because they can decompose naturally (Septiati *et al.*, 2022).

Another phenomenon during the experiment is the physiological behavior of P. Americana after the treatment. The majority of the samples flip over and show signs of spasms, and some show signs of paralysis. According to Davies (2021) of Truly Nolen Pest Control Canada, using insecticides such as chili extract at high concentrations blocks the communication of the nerves to the muscles, causing the cockroaches to move uncontrollably and flip over on their backs. The biomechanical configuration of a cockroach, characterized by a high center of gravity due to its elongated limbs and a convex exoskeleton, predisposes it to remain inverted following involuntary muscle contractions, often induced by insecticidal exposure. In healthy individuals, coordinated leg and wing movements facilitate self-righting maneuvers, propelling the body into an oscillatory motion, culminating in upright recovery. However, insecticide-affected cockroaches exhibit impaired neuromuscular control, rendering them incapable of executing these compensatory motor actions, persisting in an inverted posture.

The Effectiveness of Varying Concentration of Chili Pepper Extract on American Cockroach

Table 3 shows the One-Way ANOVA examining the difference in the concentration effectiveness of chili pepper extract on the American cockroach. It presents a p-value of 0.000102, which is significant at the 0.05 level, thus rejecting the study's null hypothesis, which states that there is no significant difference among the varying concentrations of chili pepper extract.

Table 2: The difference of the varying concentrations of Chili pepper extract on American cockroaches using a one-way ANOVA test

Source	Df	Sum Sq	Mean Sq	F Value	p-Value
Between Groups	2	4.5714	2.2857	16	0.000102*
Within Groups	18	2.5714	0.1429		
Total	**20**	**7.1429**			

**Significant at 0.05 level*

It implies that different concentrations have different effects on the specimen. A study revealed that the higher the concentration, the faster it works. The higher the concentration of capsaicinoids, the more effective and faster they work as bioinsecticides (Claros-Cuadrado *et al.*, 2019). According to the study of Ruedt *et al.* (2022), they utilized salt concentration to treat iridescence in pork. The experiment revealed that a high concentration yields a higher score than a concentration below the highest.

CONCLUSIONS

This study demonstrated the promising potential of chili pepper (*Capsicum annuum*) extract as an organic pesticide against American cockroaches (*Periplaneta americana*). Higher concentrations of chili pepper extract exhibited significantly improved efficacy, achieving faster kill time and higher mortality rates than lower concentrations. The observed cockroach behavior, including spasms, paralysis, and flipping, aligns with the known neurotoxic effects of capsaicinoids, the active ingredient in chili peppers. Statistical analysis further confirms the significant difference in effectiveness across concentration groups.

Acknowledgments

The authors thank the following people: Darlene Ricarte, Michael Ricarte, Michelle Darlyne Ricarte, Celeste Marie Ricarte, Von Michael Ricarte, Sheen Mae Antiquin, Joseph Tapic, Jay Cuesta, Kyle Honculada Charm Joshean

Tapic, Winalyn Velicitat, Nielfred Sumandac, Riza Jane Ylanan, Neonila Sumandac, and Wilfredo Sumandac. The authors also thank Sir Jerald C. Dubiao and Sir Lester F. Flores for confirming our samples. The same gratitude is extended to the Paramount School of Arts, Languages, Management, and Sciences Incorporated for allowing them to utilize available school resources for their study.

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