Chili Pepper (*Capsicum frutescens*) and Calamansi (*Citrofortunella microcarpa*) extracts as an Alternative Organic Insecticide on *Periplaneta americana*: An Experimental Study

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ABSTRACT

This experimental study investigated the efficacy of a combined organic insecticide derived from chili pepper (*Capsicum frutescens*) and calamansi (*Citrofortunella microcarpa*) extracts against the American cockroach (*Periplaneta americana*). The study aimed to provide a safer, eco-friendly alternative to synthetic chemical insecticides, which pose risks to human health and the environment. Using a between-subjects experimental design, the researchers tested varying concentrations of the extracts and compared their performance to a commercial insecticide (Baygon) through mortality rate observations and a survey of 39 Grade 12 students. The results indicated that the combination of 70% chili pepper and 30% calamansi extracts demonstrated significant insecticidal effectiveness. Statistical analysis using a paired t-test revealed that the organic formulation was significantly more effective than the commercial product in terms of consumer perception and performance metrics. While participants noted that the scent of the organic insecticide may require improvement, the findings suggest that the *C. frutescens* and *C. microcarpa* mixture is a viable, sustainable, and less toxic alternative for household pest control. Further research is recommended to refine the formulation's odor and test its efficacy in practical, real-world settings.

Keywords: *Capsaicin*; *D-limonene*; Calamansi (*Citrofortunella microcarpa*); Chili pepper (*Capsicum frutescens*); Alternative Organic Insecticide; Lynch's Formula

CHAPTER 1: INTRODUCTION

Pest control is a major concern in both farms and homes, especially when it comes to common pests like cockroaches (Gondhalekar et al., 2021). While chemical insecticides are widely used, they come with risks such as environmental harm, toxicity to humans and pets, and the possibility of pests developing resistance (Geng et al., 2025; Lee, 2000; Derguini & Basher, 2026). Because of these issues, many people are looking for safer, natural alternatives, and plant-based insecticides are becoming a promising option (Ayilara et al., 2023; Hikal et al., 2017). Chili pepper and calamansi are two common plants that have insecticidal properties. Chili peppers contain capsaicin, which irritates and repels pests, while calamansi has citric acid and essential oils that could act as natural insecticides (CABI, 2023; Caugma et al., 2020). This study explores whether extracts from these plants can effectively repel or kill cockroaches, offering a potential eco-friendly solution to household pest problems.

1.1 PROBLEM AND ITS BACKGROUND

Cockroaches living near humans pose a public health risk due to their capacity to contaminate food and surfaces (Kakumanu & Schal, 2026). They can transport disease-causing microbes (pathogens) to food and areas where food is handled, potentially leading to foodborne illnesses (Donkor, 2020). Cockroach body parts and debris contain allergens that can induce allergic reactions and asthma attacks in sensitized individuals (Bhavnani et al., 2024; Gondhalekar et al., 2021). Dealing with cockroaches in homes can be a major inconvenience. In addition to being unsightly, they also harbor substances like excrement on their body (Bhavnani

et al., 2024). Releasing these substances into the air can result in allergic reactions or asthma attacks. Debris from deceased cockroaches, body fragments, or feces can also cause allergies or asthma.

P. americana (*house cockroach*) emits a strong, unpleasant odor that can be detected in the presence of a significant infestation (Schal, 2026; Hoffmann & Couzin-Fuchs, 2023). Cockroach allergens can cause chronic symptoms that last longer than other seasonal allergies. Compared to other seasonal allergies, cockroach allergens can produce symptoms that persist longer (Thermo Fisher Scientific, 2021). The community is seriously at risk from cockroaches since they propagate deadly infections that are bad for people's health (Derguini & Basher, 2026; Badri et al., 2025).

Furthermore, they have been known to bite people, specifically in parts of the body which are partially associated with personal hygiene, including the borders of the mouth or hands, fingers, or fingernails (Uieda & Haddad, 2014). This happens when there is a shortage of food or a high cockroach population, and the cockroaches get extremely hungry. Generally, cockroach allergies are not any worse than mosquitoes' bites, though they can sometimes cause a swelling reaction and itching, as well as, in more extreme cases, allergies or skin infections (Arruda & Chapman, 2001).

Spanish pepper or mainly known as "labuyo chili" are part of the Capsicum genus which are plants noticeable for their hot flavor and contain numerous antioxidants, vitamins, and minerals (Muthuswamy, 2021). This variety of peppers are one of two main varieties found throughout the tropical country of Philippines and are averaging 80,000-100,000 Scoville Heat Units (SHU) on the Scoville heat scale (Sarpras et al., 2016). The peppers contain *capsaicinoids*

(or commonly known as *capsaicin*) that are organic compounds that have been demonstrated in research to have anti-inflammatory and antibacterial properties (Nascimento et al., 2014; Koffi-Nevry et al., 2012). The *capsaicin* content of *C. frutescens* has been employed in Filipino traditional medicine as a completely organic toothache treatment for pain (Muthuswamy, 2021).

Chilli pepper extracts have been used to control a wide range of insect pests, both in traditional home preparations and commercial products. Its main target pests are aphids, loopers, armyworms, spider mites, thrips, leaf miners and whiteflies (Li et al., 2019; CABI, 2023). It also shows significant effects on house cockroaches (Periplaneta americana) (Alarcon et al., 2023). It does not meet any of the highly hazardous pesticides, in usual use, *capsaicin*-containing products are primarily used to repel insects rather than to kill existing infestations (Maliszewska & Tęgowska, 2012). *Capsaicin*'s toxicity appears to focus on metabolic disruption, membrane damage, and nervous system dysfunction. The higher the concentration of chili pepper extract, the higher the repellent effect was on the insects. However, recent studies showcased that this compound is potent enough to actually kill insects (Kamezaki & Nishiwaki, 2025; Koleva-Gudeva, 2013).

Capsaicin is also an effective animal repellent, having been registered for use as an miticide, rodenticide, and feeding depressant. It is registered to repel vertebrate pests such as rabbits, squirrels, deer, voles, raccoons, and skunks (National Pesticide Information Center, n.d.).

Recently, exotic citrus fruits have attracted attention worldwide, due to their unique sensory attributes and health benefits (Riaz et al., 2023). These include reducing blood pressure, decreasing arteriosclerosis, assisting in the treatment of respiratory ailments including cough and asthma, and improving eye health. It is a fruit with various medical uses because it also possesses

immune-stimulating, anti-inflammatory, and digestive properties (Mahmoud et al., 2019; Xu et al., 2025).

Calamansi also contains the compound *D-Limonene*, which is proven to be effective in insecticidal activities. It is produced from citrus extracts and is used as a contact insecticide against ants, roaches, and other insects (Lin et al., 2024; Silwanyana, 2026; Capili et al., 2019). It has a basic taste that irritates insects by destroying the wax coating of their respiratory system, making it an effective repellent (Lin et al., 2024). *D-Limonene* alos has low oral and dermal toxicity to mammals, birds and fish.

C. microcarpa extracts in research were deemed effective, however it takes time to kill the cockroaches (Alzogaray, 2013). However, *Calamansi* compound - focused insecticides can be eco-friendly, cheaper and have lower health risk to the user due to its naturalness (Ngegba et al., 2022).

1.2 STATEMENT OF THE PROBLEM

This research study aims to establish the effectiveness of *C. frutescens* and *C. microcarpa* as major elements of an alternative organic insecticide. The study investigates the following:

1. How effective is the combination of chili pepper and calamansi as an organic insecticide for P. americana?

1.1 Rate of how fast P. americana dies.

2. What concentration level and percentage between both extracts will bring a higher case of effectivity?

2.1 Comparison of various samples in different combined concentration levels through scientific testing (e.g. toxicity rate) such as:

Product a: 70% *C. frutescens* and 30% *C. microcarpa* extracts in 30 mL solution.

Product b: 70% *C. microcarpa* and 30% *C. frutescens* extracts in 30 mL solution.

Product c: 50% *C. frutescens* and 50% *C. microcarpa* extracts in 30 mL solution

3. Comparison Between Organic and Chemical Insecticides

The study compares the efficiency, safety, and effectiveness of the organic insecticide made from *Capsicum frutescens* (chili pepper) and *Citrufortunella microcarpa* (calamansi) against commercial products which is the chemical insecticide. The comparison will focus on the following:

3.1 Effectiveness Comparison

The mortality rate of *Periplaneta americana* will be done for both the organic insecticide and commercial product. The effectiveness will be measured based on the time taken for after exposure to each insecticides. There will be a comparison between the deemed most effective concentration in killing a cockroach based on time taken when the concentration was applied and *product X*. A T-test will be conducted to determine if there is a significance between the effectiveness of the organic insecticide and the commercial product.

3.2 Health and Environmental Risks

The toxicity of both the insecticides will be determined based on their ingredients and impact on human health and environment. Observations will be conducted to include possible allergic reactions caused by the organic insecticide and considering the strong scent of chili pepper and calamansi.

1.3 RESEARCH QUESTIONS

1. How effective are the combined concentrations of *C. frutescens* and *C. microcarpa* extracts as an organic insecticide on *P. americana*?

2. In measurable and comparable terms, how effective is the most effective concentration in killing a *P. americana* compared to a specific sold product in the market (*Product x*)?

3. Through testing, what levels of combined concentrations (e.g. *30% C. frutescens* and *70% C. microcarpa* extracts) are deemed to produce greater effects on *P. americana*?

4. Which qualities of the produced organic product are deemed suitable to be considered as an alternative?

1.4 RESEARCH OBJECTIVES

This research seeks to explore how siling labuyo (*Capsicum frutescens)* and calamansi (*Citrofortunella microcarpa*) could be vital elements of an organic pesticide that is potent enough to eradicate house cockroach (*Periplaneta americana*) in a household scale.

1. To evaluate the effectiveness of combined concentrations of combined *C. frutescens* and *C. microcarpa* extracts on *P. Americana.*
2. To identify if the most effective concentration is more effective compared to a specific sold product market (*product X*).
3. To compare the findings regarding the effectiveness of the most effective concentration produced from different concentrations and a product sold in the market of the product X.
4. To identify final qualities after findings in which the product will be deemed suitable as an alternative.

1.5 SCOPE AND DELIMITATION

The aim of this experimental investigation is to see how effective C. frutescens and C. microcarpa extracts are as an alternative insecticide anchored on P. americana. The experimentation will undergo paired t-tests.

The researchers will conduct a paired t-test to evaluate the effectiveness of a mixture consisting of 70% chili pepper and 30% calamansi in comparison to Baygon. They will examine the variations in mortality rates observed under controlled conditions. This method will enable the researchers to identify any statistically significant differences in effectiveness between the two treatments.

1.5. SIGNIFICANCE OF THE STUDY

This study will benefit the following:

The Students: This study will benefit the students by providing credible information about the effects of *C. frutescens* combined with *C. microcarpa* against household cockroaches and it can also be used as references for their academic research.

The Teachers: This study provides credible information about the combined effects of *C. microcarpa* and *C. frutescens* against household cockroaches and can be utilized for teaching purposes or references.

The Household consumers: The result of this study aims to create an alternative insecticide against household cockroaches that will benefit our household consumers thus providing a better organic alternative rather than buying insecticides on the market.

The Researchers: This study aims to test the effects of *C. frutescens* and *C. microcarpa* against *P. americana*. Thus the results will provide credible information viable for future researchers in the field.

1.6 HYPOTHESIS

The following hypotheses was tested in the study:

Null hypothesis (H_0): The organic pesticide produced from *C. frutescens and C. microcarpa* does not have effect on *P. americana.*

Alternative hypothesis (H_1): The organic pesticide produced from *C. frutescens and C. microcarpa* extracts has a significant effect in killing a *P. americana.*

1.7 DEFINITION OF TERMS

Organic Insecticides - Refers to pesticides made from natural sources such as plant extracts from *Capsicum frutescens* and *Citrofortunella microcarpa* that would be used as an alternative to synthetic pesticides for controlling pests such as *Periplaneta Americana.*

Capsicum frutescens - Closely related to *Capsicum annuum* which would be used for its insecticidal properties.

Citrofortunella microcarpa - A small citrus fruit that is investigated for its effectiveness in killing and repelling pests.

Periplaneta americana - A common household pest that this research aims to control by using a combination of *Capsicum frutescens and Citrofortunella microcarpa* as organic insecticides.

Capsaicin - One of the primary insecticidal agents in the chili pepper tested for its ability to kill or repel pests.

Antioxidants - Inhibits oxidation and neutralizes free radicals.

Proliferated - The rapid increase in population of pests like the *Periplaneta Americana* that the research aims to control with the use of organic insecticides.

Scoville Heat Units (SHU) - Measures the heat level of *Capsicum frutescens* which may correlate to its effectiveness as an insecticide.

Excrements - Waste produced by pests like cockroaches which can help in investigating cockroach activity.

Botanical Insecticides - Plant-based insecticides derived from *Capsicum frutescens* and *Citrofortunella microcarpa*.

CHAPTER 2: REVIEW OF RELATED LITERATURE

This chapter presents and discusses the review and relevant literature on an experimental study examining Chili Pepper (*Capsicum frutescens*) and Calamansi (*Citrofortunella microcarpa*) extracts as alternative organic insecticides for Periplaneta americana. It aims to provide a thorough analysis of key concepts to ensure a comprehensive understanding of the topics cited throughout the research.

2.1 REVIEW OF RELATED LITERATURE

The adoption of organic insecticides has gained prominence as a viable pest management strategy within residential and community settings. This shift is driven by the urgent need to control cockroach populations, which serve as mechanical vectors for a diverse spectrum of human pathogens (Bhavnani et al., 2024; Donkor, 2020). Due to their synanthropic nature, cockroaches frequently inhabit environments such as domestic residences, healthcare facilities, and industrial complexes, where they harbor fungi, viruses, bacteria, and parasites on their cuticular surfaces and within their digestive tracts (Kassiri et al., 2014).

Furthermore, the dietary plasticity of cockroaches, characterized by their scavenging and omnivorous feeding habits, enables them to interact with diverse substrates, thereby facilitating the mechanical transmission of various infectious agents, including protozoans, to human food sources and living spaces (Geng et al., 2025).

While synthetic chemical insecticides have historically been utilized to enhance agricultural productivity, particularly within the context of African food security, their application has incurred significant ecological and operational costs. The indiscriminate use of these chemical agents has resulted in the suppression of beneficial non-target organisms and the proliferation of pesticide resistance among target insect populations (Baidoo & Mochiah, 2016).

Consequently, there is an increasing scientific imperative to develop and implement alternative control measures, such as botanical and organic insecticides, that mitigate these adverse impacts while effectively managing pest-related public health risks.

2.2 RELATED STUDIES

2.2.1 Organic Insecticides

Non-toxic to humans

It is important for humans to be aware of the toxicity of the pesticide that was used. The susceptibility of the American cockroach, *Periplaneta americana L*. (Blattodea: Blattidae), against malathion was tested in the laboratory. The levels of insecticide detoxifying enzymes among different populations of P. americana were also compared. Standard methods were used for the estimation of non-specific esterases, glutathione S-transferases (GSTs) and monooxygenases. All populations showed resistance against malathion and significantly higher activities of insecticide detoxifying enzymes were recorded as compared to the susceptible population control (Tahir et al., 2017). The negative impact of chemical pesticides for user safety is that they can directly contaminate users, resulting in poisoning.

Eco-friendly

The environmental sustainability of organic and botanical biopesticides is intrinsically linked to their natural, biodegradable constituents, which facilitate targeted pest suppression without inducing chronic ecotoxicity. Driven by escalating public health and ecological concerns associated with the persistence and bioaccumulation of synthetic chemical compounds, contemporary agricultural science has increasingly pivoted toward eco-friendly pest management paradigms (Ngegba et al., 2022). As synthesized by Verma et al. (2023), this paradigm shift

toward biopesticides mitigates chemical contamination of soil and aquatic strata while preserving regional biodiversity.

This tension between ecological preservation and crop yield optimization is particularly pronounced in the cultivation of high-stakes crops like brinjal (*Solanum melongena* L.), which are highly susceptible to debilitating infestations such as the brinjal shoot and fruit borer (*Leucinodes orbonalis*). Addressing these agricultural challenges requires a calibrated approach that balances eco-centric priorities with the economic necessity of high-yield farming. Consequently, maximizing output while protecting local biomes necessitates the rigorous deployment of integrated pest management (IPM) strategies, combining the dosage precision of targeted chemical intervention with the long-term sustainability of biorational controls (Pandey et al., 2023; Chaudhary et al., 2024).

2.2.2 Natural Ingredients

Environmental Impact

A field experiment was carried out in Makonde District, Mashonaland West Province of Zimbabwe to evaluate the effectiveness of hot chilli pepper (Capsicum frutescens l.) extracts in managing major pests of cabbage (Brassica oleracea l.) under rain fed conditions during 2017/2018 rainy season. A Randomised Complete Block Design (RCBD) with 4 different concentrations of hot chilli pepper extracts (0.02 m/v, 0.04 m/v, 0.06 m/v and 0.08 m/v), synthetic insecticide (Imidacloprid + beta cyfluthrina) as the positive control and no insecticide application as the negative control was used in the study. Diamond back moths (DBM), cabbage looper, cross striped cabbageworm, snails, cabbage webworm, aphids colonies, ladybird beetles, wasps were counted at 2, 4, 6, 8 and 10 weeks after transplanting. (Gumbeze et al., 2023) The

results showed that 0.08 m/v concentration of hot chilli pepper extract was determined to be the most effective, performing significantly better than the lower concentrations in managing the targeted pest populations. It also resulted in the highest marketable yield of cabbages. Conversely, the negative control (no insecticide) produced the lowest marketable yield.

This study shows how a disease can easily contaminate our food houses, prevention and how cleanliness is important. Microorganisms causing disease is blind to human eyes, it brings diseases to our foods, places and stuff that are prone to be touched (Geng et al., 2025). There is a risk to people's health when cockroaches live close to people since they can contaminate surfaces and food. They may transport bacteria, which are microorganisms causing disease to food and places wherein food is prepared, presumably leading to foodborne infections (Gondhalekar et al., 2021).

Calamansi has evolved into a viable natural replacement for synthetic insecticides in the field of pest control. The efficacy of citrus-based compounds, in particular *d-limonene*, to repel cockroaches as well as other bug species away has become the focus of numerous studies. Research points out that calamansi's bitter substances have insecticidal and repellent qualities that have been effectively applied to prevent pests in residential as well as commercial environments. Results suggest that calamansi peel extract is a potential insecticide against BPH and could be utilized as an organic plant-based insecticide (Caugma et al., 2020).

The pervasive use of synthetic chemical pesticides in contemporary agriculture has precipitated significant environmental degradation and public health crises, including soil contamination, water pollution, and the presence of toxic residues in agricultural produce (Kim et al., 2023). Consequently, there is an urgent scientific mandate to transition toward sustainable,

botanical-based pest management systems. Botanical pesticides, derived from natural plant sources, offer a viable alternative, functioning as potent contact insecticides or repellents with reduced ecological footprints (Ngegba et al., 2022).

Waste Reduction

Several studies have demonstrated that wastes from agricultural and food processing industries such as fruit and vegetable peels contain high amounts of polysaccharides that can be transformed into useful chemicals, including lactic acid, through fermentation. Paper chromatography results likewise confirmed that the crystals are lactate. *C. microcarpa* fruit waste can afford lactic acid when fermented with L. plantarum. The results of the study may serve as the basis for the development of technology for the utilization of *C. microcarpa* fruit waste biomass as a renewable resource for industrial production of lactic acid (Ortinero et al., 2017). Peels from vegetables and fruits, including *Citrofortunella microcarpa* (calamansi), are rich in complex carbohydrates called polysaccharides. Since these polysaccharides may be split into much more basic sugars and then tranBy preventing this material from ending up in landfills, the process also serves to reduce environmental harm and advance a circular economy. *Citrofortunella microcarpa* (calamansi) and other fruit and vegetable peels are a good source of complex carbohydrates known as polysaccharides. These polysaccharides are excellent substrates for microbial fermentation because they can be broken down into considerably more basic sugars and then converted into organic acids or other chemicals. By preventing this material from ending up in landfills, the process also serves to reduce environmental harm and advance a circular economy formed into organic acids or other compounds, they serve as a great substrate for microbial fermentation.

2.3 LOCAL STUDIES

Capsicum frutescens L., colloquially known in the Philippines as "siling labuyo," is renowned primarily for its intense pungency, a characteristic increasingly studied for its diverse therapeutic and functional applications. Investigations into its clinical utility include the development of topical formulations; for instance, Paterno et al. (2019) evaluated the safety, efficacy, and sensory acceptability of a localized *siling labuyo* liniment as a non-pharmacological intervention for the management of knee osteoarthritis.

Beyond its analgesic properties, the plant is recognized for its potent antimicrobial activity, attributed to high concentrations of bioactive secondary metabolites (Segalle et al., 2019). Despite the abundance of *C. frutescens* cultivars within the Philippines, there remains a paucity of empirical research comprehensively characterizing their antibacterial potential. Consequently, further investigation into these endemic cultivars is essential to validate their efficacy as sustainable, natural antibacterial agents in pharmaceutical applications (Segalle et al., 2019).

Furthermore, *Capsicum* fruit extracts have demonstrated significant insecticidal potential against common domestic pests. Building upon this efficacy, the current study evaluated the insecticidal properties of *Capsicum frutescens* fruit extract against dry-wood termites (*Cryptotermes* spp.). The extract was obtained through mechanical expression (squeezing) of the fruit. In this bioassay, fifteen termites were segregated into three experimental units (containers) and subjected to varying concentrations of the extract for a 12-hour observation period. The control group (Container A) exhibited no mortality, whereas the group exposed to a 100% concentration of the extract (Container B) demonstrated immediate lethality, with total mortality

achieved within 5 minutes. Additionally, a solution consisting of a 1:1 ratio of chili extract and distilled water (Container C) resulted in total termite mortality within a two-hour period. These results indicate that *C. frutescens* fruit extract possesses significant insecticidal efficacy against household termites, suggesting its potential as a viable, organic alternative to synthetic termiticides (Colon et al., 2016).

On the other hand, a study by Rica (2015) on the the efficacy of *Calamansi* pulp extract as insecticide against cockroaches was onducted in the Philippines that investigated the potential of *Citrofortunella microcarpa* (calamansi) as an organic, low-cost pest control agent. The research employed a single-group design to test three different concentrations of calamansi pulp extract (30%, 60%, and 90%) to determine their lethal effects on cockroaches. The study's primary hypothesis was that the extract could act as a viable alternative to commercial chemical insecticides, utilizing the insecticidal properties of limonene,a natural terpene found in high concentrations in citrus, which functions by disrupting the respiratory wax layer of the insect's exoskeleton, leading to desiccation and death.The results of the investigation indicated that the efficacy of the extract was concentration-dependent, with mortality rates increasing at higher concentrations. Specifically, researchers observed that while the 30% concentration resulted in minimal to no mortality, the 60% and 90% concentrations yielded higher rates of cockroach mortality over a three-hour observation period. While the extract showed potential as a natural insecticide, the study acknowledged that it generally required longer contact times to achieve results compared to high-potency synthetic commercial products (like organophosphates or pyrethroids), which typically achieve 100% mortality in controlled settings. Ultimately, the research concluded that calamansi pulp extract serves as a feasible, environmentally safer, and cost-effective supplement for household pest management.

In addition, a study by Alarcon et al. (2024) investigated the insecticidal potential of chili pepper (*Capsicum annuum*) extract against the American cockroach (*Periplaneta americana*). Using an experimental design, the researchers applied three concentrations of the extract—50%, 75%, and 100%—to cockroaches and monitored mortality rates over a 24-hour period. The findings demonstrated a clear dose-response relationship: the 100% concentration achieved a 100% mortality rate (3 out of 3 specimens) across all trials with an average knockdown time of 29.5 minutes. In contrast, the 75% and 50% concentrations resulted in lower average kill rates and slower mortality times of 50.7 and 83.1 minutes, respectively.

Statistical analysis via one-way ANOVA confirmed that increasing the concentration of the chili extract significantly enhances its efficacy as a pesticide. The authors concluded that while *Capsicum annuum* extract shows promise as a sustainable, eco-friendly alternative to synthetic chemicals for household pest management, it requires further optimization and rigorous assessment of its long-term health and environmental impacts. The study supports the growing body of research into botanical insecticides, suggesting that these natural extracts can serve as effective, safer tools for integrated pest management practices.

CHAPTER 3: METHODOLOGY

3.1 RESEARCH DESIGN

Properly investigating the effectiveness of varying concentrations for C. microcarpa and *C. frutescens*, the researchers will utilize scientific set-ups and experimental designs to gather specific data that need to be analyzed to reach scientific inferences that would define the accuracy of the hypotheses based on the comparison between the organic pesticide and *Baygon* in the paper.

In accordance with the quantitative nature of the study, the researchers must use a research design that will help exemplify objectivity of the experiment to be done, therefore increasing the validity and reliability of the research's content. Thus, the researchers decided to employ the *Between-Subjects Experimental design*. This design is focused on having different sets of participants, in which then is assigned to varying experimental conditions, in this case, the different sets of pesticide application using the three combined concentrations of organic products. An additional group will be treated with *Baygon*, a chemical pesticide available in the market, to serve as a comparative control. One group will only be presented by one specific concentration, creating a total of four experimental groups.

This incurs the reality of interplay between the design type and substantive independent variable. Then, in simpler terms, that data occured and gathered from the presented experimental trials will then undergo complex comparison through survey analysis and variance computations, therefore implying the concentrated pesticide that manifested the greatest results against *P. americana* through the measurable factors that will be further included in research methodology.

The application of this experimental design was evaluated through comparative analysis of another design, the *Within-Subjects Experimental design* under factors that is tied to the paper. The chosen design needs access to larger participants compared to the other one. However, upon further discussion, the sample size then became negligible as the locus of consideration relied on the presumed objectivity, generalizability and validity of the experiment and the participants.

The carry-over effect will most likely affect the participants of Within-Subjects design. This phenomena occurs when a specified condition affects or influences the experience they have on another condition. This is due to the group being treated on different conditions consequently (Keren, 2014). This might cause participants to feel fatigued, uninterested or distracted by other participants behaviors and biases, which could fail the experiment to create objective results. Therefore, the utilization of Between-Subjects Experimental design will create a much more effective environment for participants to deduct the data from the scientific experiment. The chosen research design will also allow more time-efficient activities, because set-ups could be started simultaneously.

The nature of the research will stand within postpositivism, as a concept referred to as the scientific method, wherein lies the investigation of our hypothesis on the effectivity of the combined concentrations as an alternative pesticide, that will undergo experimentation within controlled conditions and objective measurements to understand the truth whether the research is valid and reliable or the hypothesis must be refuted.

3.2 RESEARCH LOCALE

The study will be conducted in Sacred Heart Academy of Novaliches, a private school located at 1155 Quirino Highway, Corner Zabarte, Barangay Kaligayahan, Novaliches 1124

since the study's main aim is to create an organic insecticide and to promote safety, as it reduces exposure to harmful chemicals, ensuring the safety of students, teachers, and staff. By utilizing natural ingredients, the project teaches the benefits of reducing chemical use in farming, which can harm both the ecosystem and human health. It provides support for agriculture practices that make farming sustainable around the world. The school would be able to interact with their community, mostly small farmers who are exposed directly to pests or their attacks, and provide them with an eco-friendly control solution. It allows the school to align with global sustainability trends, educating students to become responsible keepers of the environment. The possible effects of organic insecticides reduce the use of chemicals that can harm students, teachers, and the environment. Organic insecticides, often made from natural ingredients, tend to be less toxic to humans and animals compared to fake chemicals. It can also help Sacred Heart Academy of Novaliches save money using local ingredients instead of buying expensive insecticides.

The participants in this paper are the 185 number of Grade 12 Students of Sacred Heart Academy of Novaliches, particularly in the section of STEM-A with a 40 total number of students, STEM-C with a 39 total number of students, and ABM with a 25 total number of students. These are the participants that the researchers picked because student's in the classroom are prone to risks caused by the insects, specifically the Cockroaches. With this experiment, the students will gain knowledge about the importance of organic insecticides in their health.

The following are the materials that will be used in the experiment to form a organic insecticides:

MATERIALS	UNIT	PRICE
Chili	3/4 Kilograms	120 PHP
Calamansi	1 Kilogram	90 PHP
Cooking Oil	1 Pack	75 PHP
Acetone	2 Small containers	40 PHP
		Total: 325 PHP

3.3 POPULATION AND SAMPLE SIZE

The population refers to a set of individuals that could be a nation or a group with the same characteristics, it divides a population into subgroups or strata and then selects samples through a random sampling method. The selected participants in this study are students from Sacred Heart Academy of Novaliches specifically grade 12 students from 3 different sections. These are the grade level and sections Grade 12-STEM A, Grade 12-STEM C, and Grade 12-ABM. There is a total population of 104 students, the Grade 12-STEM A is composed of 40 students, the Grade 12- STEM C is composed of 39 students, and the Grade 12-ABM has 25 students.

This study's sample was first computed with Lynch's Formula, in which the researchers selected 39 students as sample from 3 different sections. Furthermore, stratified sampling

technique was used to divide the samples into different strata, after that simple random sampling technique was used randomly to select participants from different sections.

LYNCH'S FORMULA:

The standard formula for calculating sample size (n) for a finite population (N) when estimating a proportion is typically expressed as:

$$n = \frac{NZ^2p(1-p)}{e^2(N-1)+Z^2p(1-p)}$$

Where: n = sample size

N= population

e = margin of error (0.05)

p= largest possible portion (0.5)

Z = standard value of probability level (95% or 1.96) (99% or 2.58)

Sample Computation:

=(104)(2.58)+[(0.05)*2(1-0.5)1/(104)(0.05)+[(2.58)*2(0.5)(1-0.5)]

=268.32125/6.8641

=39.0905217 or 39

Sample Proportion:

39/104 × 100% = 37.5% or .375

40 x 375 = 15

39 x .375 = 15

25 x .375 = 9

Total = 39

The researchers came up with this population and sample size because this study is focused on the results of the different concentration tests for the combined extracts of chill extract and calamansi extract as an organic insecticide against household cockroaches, and finding the most effective concentration between the three different concentrations. Furthermore, the proven most effective concentration will be compared with the *product X* and this comparison will be determined by both the experiment and the responses of the respondents on the data gathered. It was to prove that the experimental testing was reliable and valid as the conducted an experimental test underwent observation by the selected random participants through the stratified random sampling method.

3.4 DATA COLLECTION INSTRUMENT

The researchers used Likert scale and face-to-face surveys to gather data in order to effectively capture participants' attitudes, opinions, and behaviors, while ensuring that the data collection process was both comprehensive and reliable. The guide questions were made based on the study's objectives and previous studies and relevant literature. Close-ended questions were provided to accommodate the perceptions of the participants regarding Chili pepper (*Capsicum frutescens*) and Calamansi (*Citrofortunella microcarpa*) extracts as an Alternative Organic Insecticide on *Periplaneta americana.*

Likert scale allows participants to express their insights since it presents respondents with a series of statements to which they can indicate their level of agreement or disagreement, providing a range of options that includes: "strongly agree, agree, neutral, disagree, strongly disagree" that simplify the expression of attitudes of opinions. This offers a clear and standardized way to quantify subjective responses and will be able to ensure consistency, making it easier to identify the correlation and analyze the data statistically.

The face-to-face survey setting provides a personal touch to the data collection process and can encourage more detailed and thoughtful answers, as respondents may feel more comfortable discussing their opinions with an interviewer. Unlike online surveys or other remote methods, face-to-face interactions fosters a deeper connection between the researcher and the participants, which leads to higher participation compared to others. This personal engagement creates an opportunity for the researcher to clarify questions during the survey, reducing misinterpretation and improving accuracy and reliability of the data collected. Combining these two methods enhances the overall quality of the research by providing both quantitative and qualitative insights, leading to a more comprehensive understanding of the study.

3.5 STATISTICAL TREATMENT OF DATA

A statistical test called a Paired sample T-test compares the means of two related groups, such as measurements taken before and after on the same individuals. It is used to assess whether the average difference between two related sets of observations is statistically meaningful. It's particularly useful when the same participants or closely matched subjects are measured twice such as under different conditions or at different times.

For the paired *t*-test, we need two variables. One variable defines the pairs for the observations. The second variable is a measurement. Sometimes, we already have the paired differences for the measurement variable. Other times, we have separate variables for “before” and “after” measurements for each pair and need to calculate the differences.

Paired T-Test Formula

Paired t-test is a test which is based on the differences between the values of a single pair, i.e., one deducted from the other. In the formula for a paired t-test, this difference is denoted by

‘d’. The formula of the paired t-test is defined as the sum of the differences of each pair divided by the square root of n times the sum of the differences squared minus the sum of the squared differences, overall n−1.

$$t = \frac{\Sigma d}{\sqrt{\frac{n(\Sigma d^2) - (\Sigma d)^2}{n-1}}}$$

Here, Σd is the sum of the differences.

Experimental Procedure

The process is as follows:

- Collection and washing of raw materials
- Baking, chopping and crushing
- Blending and filtration
- Measuring and mixing
- Storage and labeling

Materials and Equipment

Material/Equipment	Quantity
Capsicum frutescens (Chili Pepper)	500g

Citrofortunella microcarpa (Calamansi)	500g
Distilled Water	1000mL
Blender	1
Strainer	1
Beakers (500mL)	3
Graduated Cylinder (100mL)	1
Glass Stirring Rod	1
Spray Bottles (250mL)	3
Digital Weighing Scale	1
Mortar and Pestle	1
Filter Paper	3
Gloves and Safety Goggles	1 pair
Mask	1
Labels	As needed
Experimental Cockroaches (Periplaneta americana)	30

Preparation of Plant Extracts

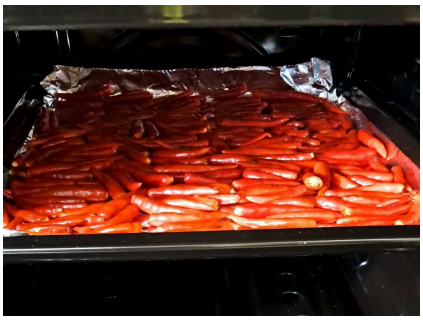
Step 1: Collection and Washing of Raw Materials



Fresh chili peppers and calamansi fruits were meticulously handpicked from local farms, with only high-quality specimens selected for further use. Upon arrival at the laboratory, the produce was sorted to eliminate any damaged or overripe samples. The selected fruits were then thoroughly rinsed with distilled water to remove dirt, pesticide residues, and other surface impurities. This preparatory step was vital to ensure the cleanliness and integrity of the raw materials prior to subsequent processing stages.

Step 2: Baking, Chopping, and Crashing



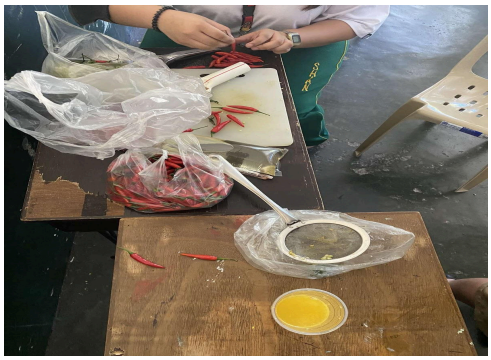




The chili peppers were first baked at a low temperature until they became slightly burnt, allowing a smoky aroma to develop. After cooling, the baked peppers were chopped into small, uniform pieces to prepare them for the next stage. In parallel, the calamansi fruits were peeled, with the peels carefully separated and reserved for extraction. Both the chopped chili peppers and calamansi peels were then manually crushed using a mortar and pestle to release their natural juices. This step was essential in breaking down the materials to obtain a concentrated mixture rich in aroma and active compounds.

Step 3: Blending and Filtration





The chili peppers were first baked at a low temperature until slightly charred, enhancing both their aroma and flavor. Following this, the peppers were chopped into smaller pieces. Simultaneously, the calamansi fruits were peeled, and the peels were set aside for later extraction. Once both materials were prepared, they were subjected to dry blending, wherein the ingredients were blended without the addition of any liquid. This method effectively crushed the materials and facilitated the release of their natural compounds, preparing them for the subsequent stage of the process.

Step 4: Measuring and Mixing



The single solution of the extract was prepared by measuring the required amount of the extracted liquid and transferring it into a clean bottle. The contents were then mixed thoroughly by shaking the bottle to ensure a uniform solution, ready for the next stage of the process.

Step 5: Storage and Labeling



The prepared solution was stored in a clean, airtight bottle to prevent contamination and preserve the integrity of the extract. The bottle was labeled with the contents, and the solution was stored under appropriate conditions to maintain its quality until further use or analysis.

CHAPTER 4: RESULTS AND DISCUSSIONS

This chapter provides the results and discussion from the data that was gathered using face to face survey questionnaires. Using the bar graph figures are the results from the 39 respondents in a relation to a research titled as Chili pepper (*Capsicum frutescens*) and Calamansi (*Citrofortunella microcarpa*) extracts as an Alternative Organic Insecticide on *Periplaneta americana*: An Experimental Study. This study anchors to support the data gathered from the respondents.

4.1 RESULTS OF THE STUDY

The mortality rate of cockroaches increased with higher concentration of 70% chili pepper and 30% calamansi.

FIGURE 1.1

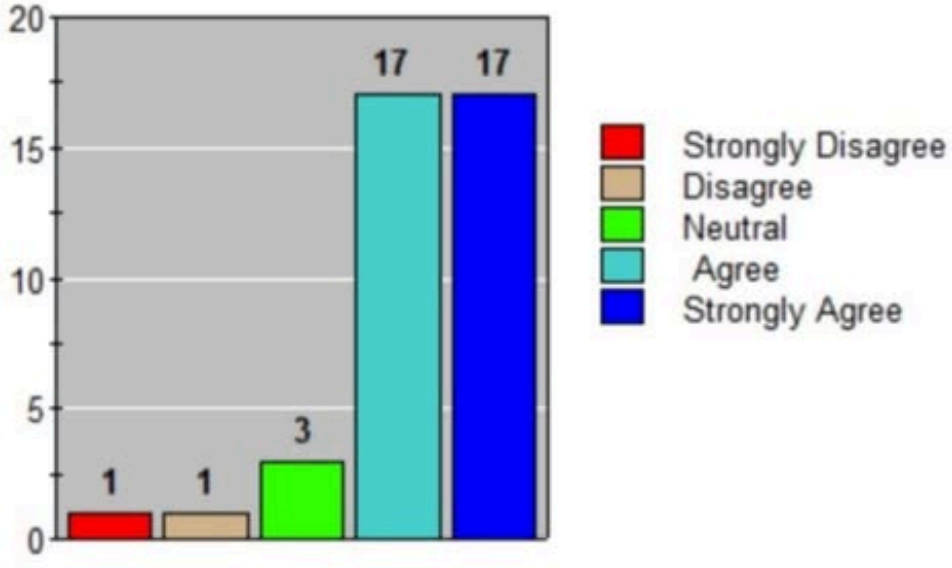


Figure 1.1 shows that most respondents agreed that Chili and Calamansi effectively increased the mortality rate of cockroaches. It shows that the majority of 39 respondent's answered Strongly Agree and Agree indicating that the Chili Pepper and Calamansi combination has the capability to increase the chance of the cockroaches to die. With this, the mean score of the data is 4.23 showing that the overall insights of respondents agreed in terms of effectivity of Chili and Calamansi. However, the 2.56% of respondent's show a strong disagreement of the combination of Chili and Calamansi while 7.69% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

The organic insecticide effectively kills the pest within the duration of 5 Minutes.

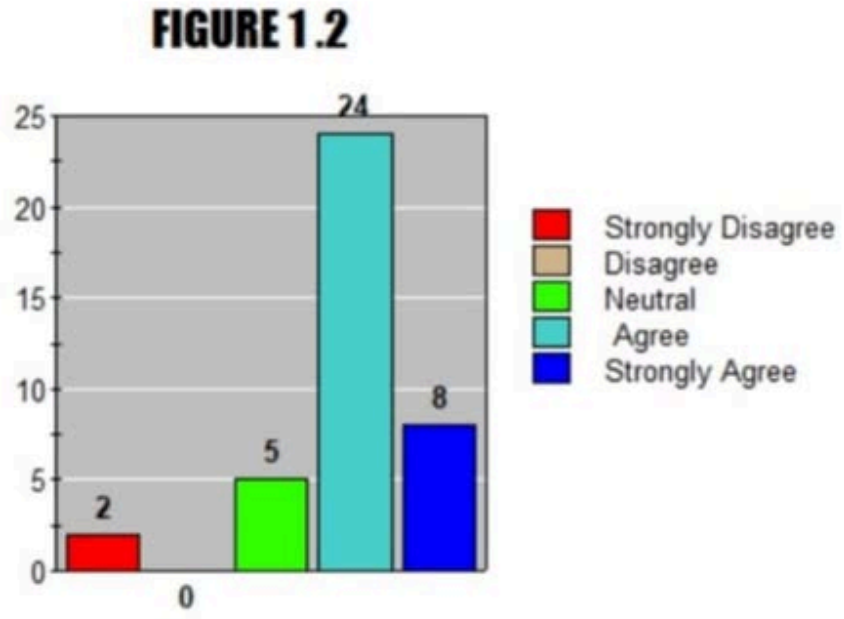


Figure 1.2 shows that most respondents agreed that organic insecticide effectively kills the pest within the duration of 5 minutes. It shows that the majority of 39 respondents answered Agree while 20.51% of the respondents showed a strong agreement, indicating that organic

insecticides can kill the pest within or faster than 5 minutes. With this, the mean score of the data is 3.92 showing that the overall insights of respondents agreed in terms of effectiveness of the duration for the pesticides to die. However, the 5.12% of respondent's show a strong disagreement of the duration for the pesticides to die while 12.32% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

The effect of 70% chilli pepper and 30% mixture in eliminating cockroaches was seen to be satisfactory and was effective in the time of use on the insect.

FIGURE 1.3

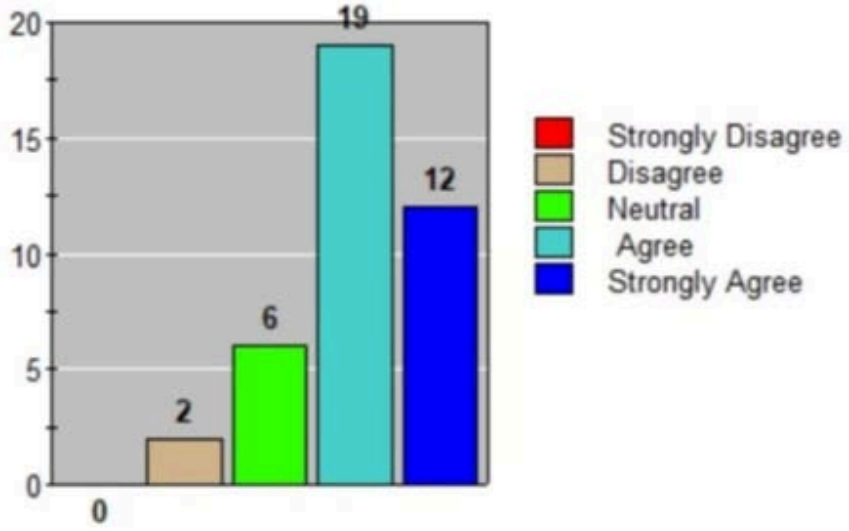


Figure 1.3 shows that most of the respondents agreed that the effects of 70% chilli pepper and 30% Calamansi mixture in eliminating cockroaches was seen to be satisfactory and was effective during the time of use. It shows that the majority of 39 respondents answered Agree (48.71%) and 30.76% of the respondents showed a strong agreement, indicating that mixture of Chili and Calamansi is effective to eliminate the cockroaches during the time or use. With this,

the mean score of the data is 4.38 showing that the overall insights of respondents agreed in terms of effectiveness of the mixture to eliminate the cockroaches. However, the 2.56% of respondent's show a strong disagreement of the combination of Chili and Calamansi while 15.38% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

Using the 70% chilli pepper and 30% mixture as an insecticide is simple and uncomplicated.

FIGURE 1.4

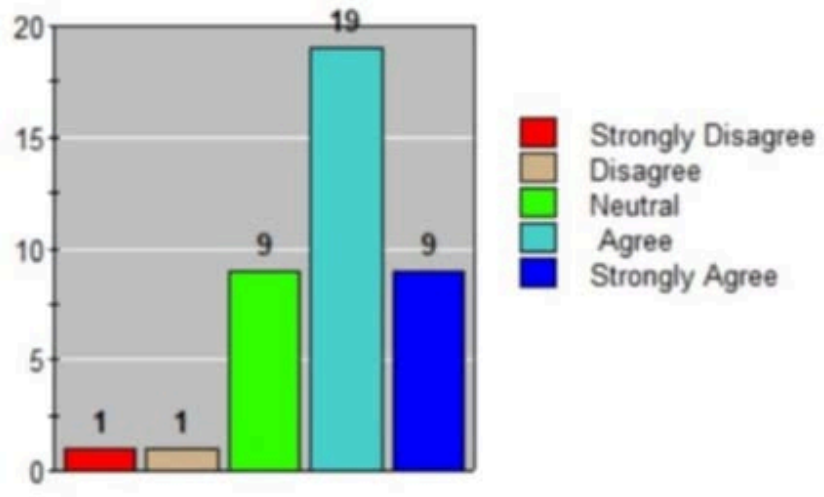


Figure 1.4 shows that most respondents agreed that using the 70% chilli pepper and 30% mixture as an insecticide is simple and uncomplicated. It shows that the majority of 39 respondents answered Agree (48.71%) and 23.07% of the respondents showed a strong agreement, indicating that mixture of Chili and Calamansi is effective to eliminate the cockroaches during the time or use. With this, the mean score of the data is 4.38 showing that the overall insights of respondents agreed in terms of using the Organic Insecticide . However, the

2.56% of respondent's show a strong disagreement of the combination of Chili and Calamansi while 15.38% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

The scent of organic insecticide is bearable while the same number stays at neutral.

FIGURE 1.5

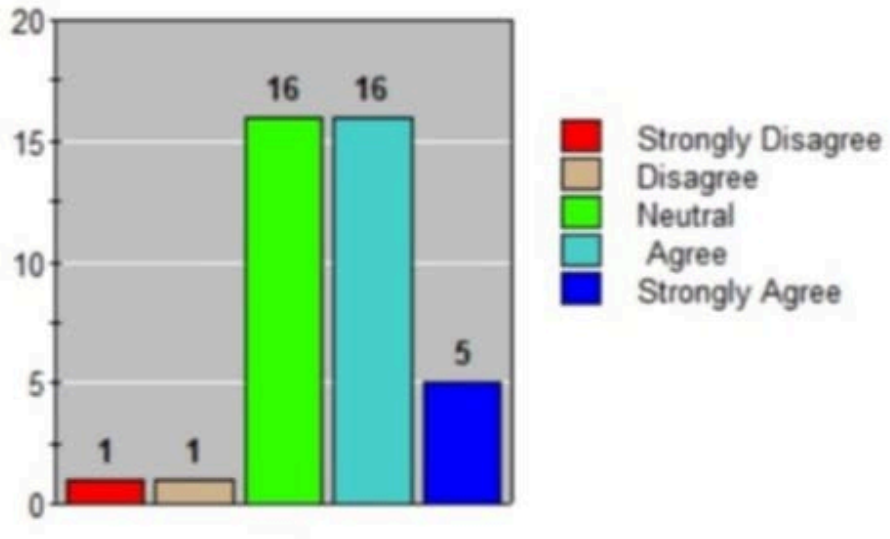


Figure 1.5 shows that most of the respondents agreed and undecided that the scent of organic insecticide is bearable while using it. It shows that the majority of 39 respondents answered Agree (41.02%) and Neutral (41.02%) indicating that the scent of organic insecticides is bearable but needs improvements. With this, the mean score of the data is 3.58 showing that the overall insights of respondents shows agreement but provides uncertainty in terms of the scent of organic insecticide. Only 12.82% of the respondents strongly agreed while 2.56%

showed strong disagreement indicating that the scent of Organic Insecticide needs improvements.

Comparative Analysis with Product X (Baygon):

FIGURE 2.1

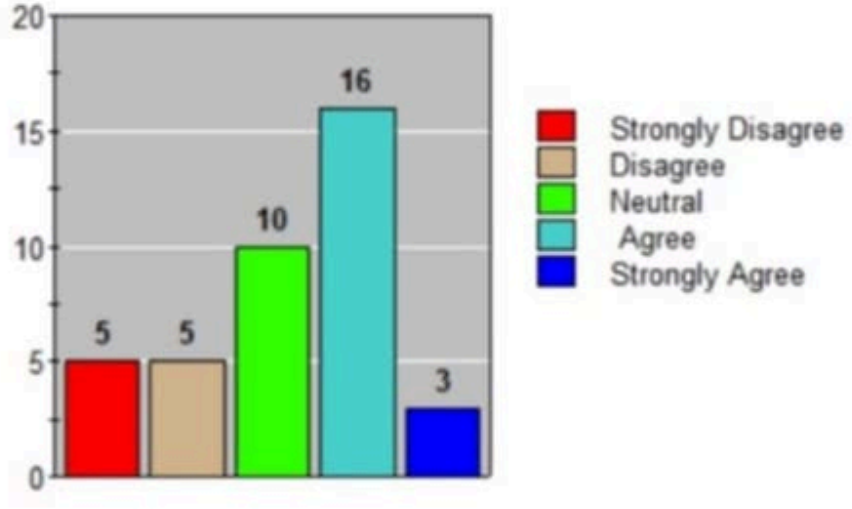


Figure 2.1 shows that most respondents agreed that Baygon effectively increased the mortality rate of cockroaches. It shows that the majority of 39 respondent's (41.02%) answered Agree and 7.69% strongly agreed indicating that Baygon has the capability to increase the chance of the cockroaches to die. With this, the mean score of the data is 3.17 showing that the overall insights of respondents agreed in terms of effectiveness of Baygon. However, the 12.82% of respondent's show a strong disagreement of the effectiveness of Baygon while 25.64% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

FIGURE 2.2

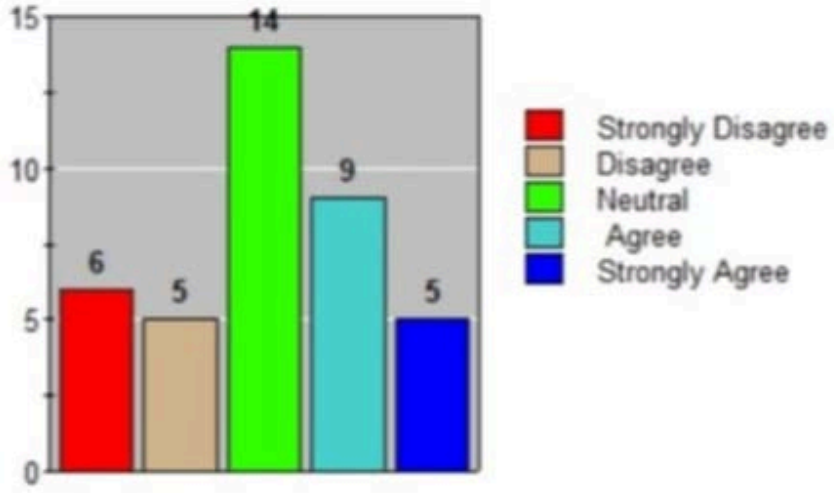


Figure 2.2 shows that most respondents are uncertain that Baygon effectively kills the pest within the duration of 5 minutes. It shows that the majority of 39 respondents answered Neutral (35.89%) while the 15.38% strongly disagreed and 12.82% disagreed, this indicates that Baygon effectively is uncertain or undecided for the respondents. With this, the mean score of the data is 3.05 showing that the overall insights of respondents in terms of Baygon's effectiveness of the duration for the pesticides to die lacks agreement or disagreement. While 20.51% of the respondents showed a strong agreement and 23.07% answered, indicating that Baygon can still kill the pest within 5 minutes.

FIGURE 2.3

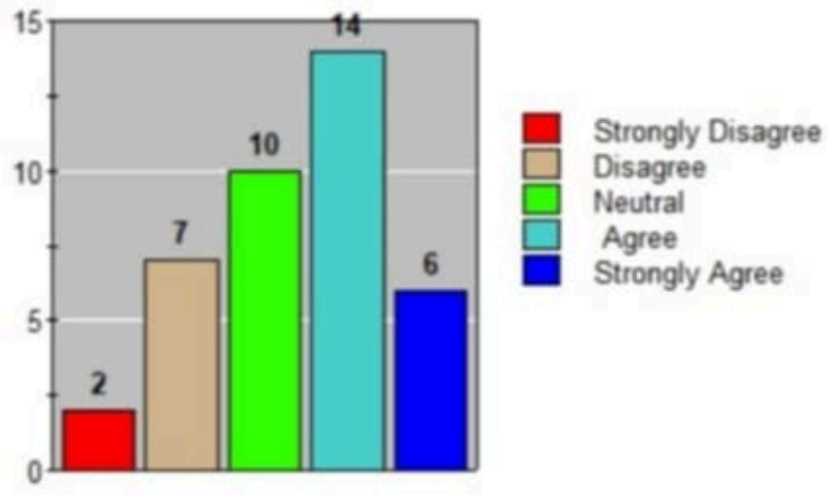


Figure 2.3 shows that most of the respondents agreed that the effects of Baygon in eliminating cockroaches was seen to be satisfactory and was effective during the time of use. It shows that the majority of 39 respondents answered Agree (35.89%) and 15.36% of the respondents showed a strong agreement, indicating that Baygon is effective to eliminate the cockroaches during the time or use. With this, the mean score of the data is 3.38 showing that the overall insights of respondents agreed in terms of effectiveness of the Baygon to eliminate the cockroaches . However, the 5.12% of respondent's show a strong disagreement and 17.94% answered disagree indicating that Baygon's effectiveness is not satisfactory in the time of use. While 25.64% of the respondents indicate that they lack strong agreement or disagreement, due to uncertainty.

FIGURE 2 .4

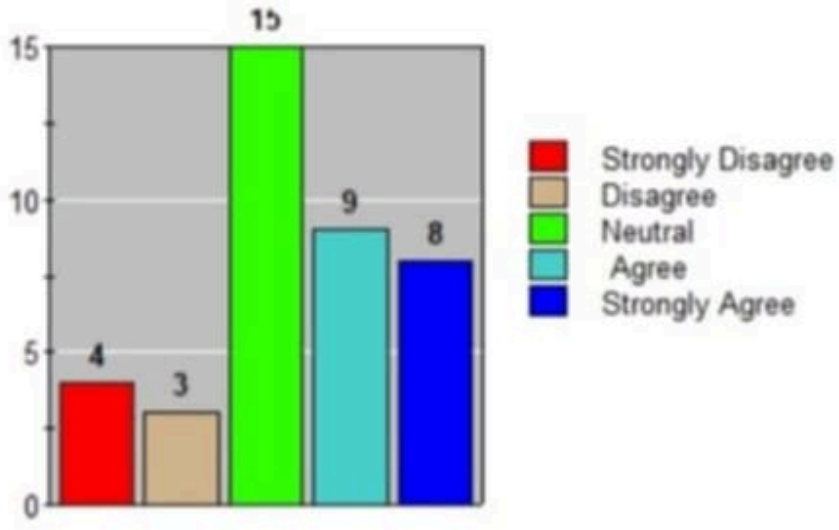


Figure 2.4 shows that the number of respondents provides uncertainty that using the Baygon is simple and uncomplicated. It shows that the majority of 39 respondents answered Neutral (38.46%) indicating that most of the respondents are undecided to recognize if the Baygon is simple and uncomplicated to use. With this, the mean score of the data is 3.35 showing that the overall insights of respondents lacks strong agreement or disagreement, due to uncertainty in terms of using Baygon. However, 20.51% of the respondents showed a strong agreement and 23.07% answered agree, indicating that Baygon is simple to use. However, the 10.25% of respondent's show a strong disagreement and 7.69% answered disagree indicates that some of the respondents find that Baygon is complicated to use.

FIGURE 2.5

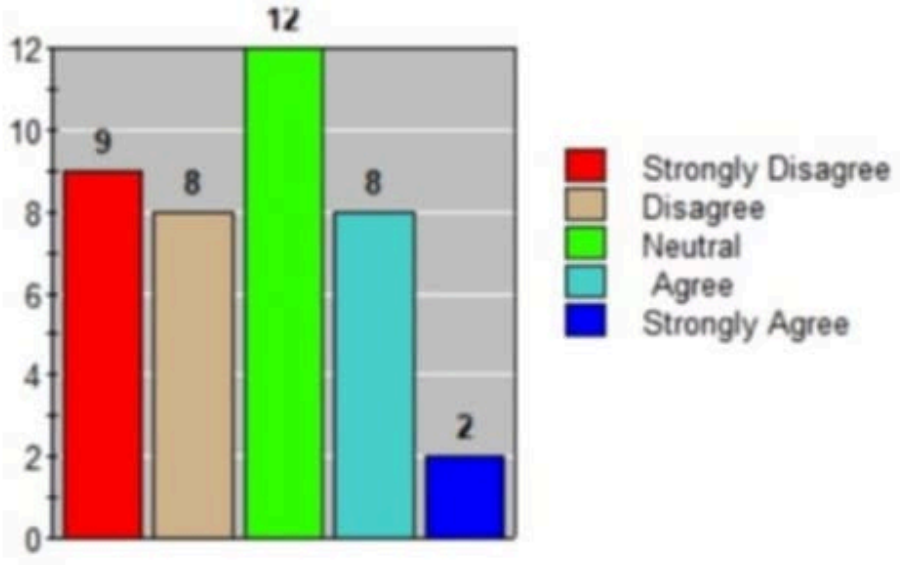


Figure 2.5 shows that most respondents indicate uncertainty that the scent of Baygon is bearable while using it. It shows that the majority of 39 respondents answered Neutral (41.02%) indicating that the scent of Baygon can be bearable or not for the respondents.

With this, the mean score of the data is 3.58 showing that the overall insights of respondents provides a lack of strong agreement or disagreement, due to uncertainty. In terms of the scent of Baygon. While 23.07% of the respondents strongly Disagree and 20.51% show disagreement indicating that the scent of Baygon needs improvements. However, 20.51% of respondents showed agreement and 5.12% strongly agreed, indicating that Baygon's scent is bearable for some of the respondents.

FIGURE 3.1

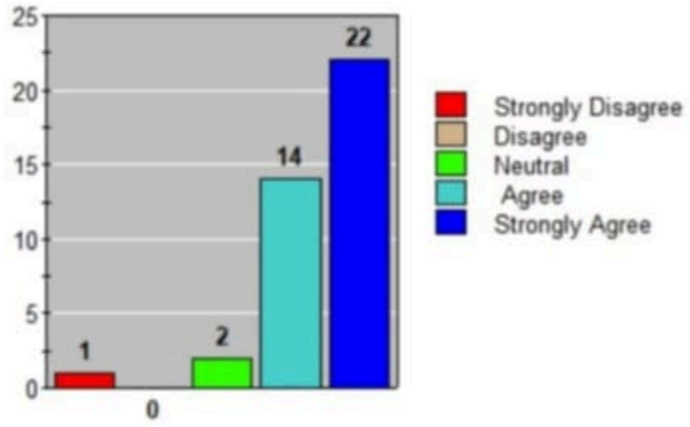


Figure 3.1 shows that most respondents strongly agreed that utilizing organic insecticides positively affects the environment compared to Baygon. It shows that the majority of 39 respondent's answered Strongly Agree (56.41%) indicating that Organic Insecticides provides a positive effect for the environment compared to Baygon. With this, the mean score of the data is 4.43 showing that the overall insights of respondents strongly agreed in terms of positive effects of organic insecticides. Only 2.56% of the respondents showed a strong disagreement, indicating that Organic Insecticides doesn't produce positive effects for other respondents,15.12% answered neutral due to uncertainty.

FIGURE 3.2

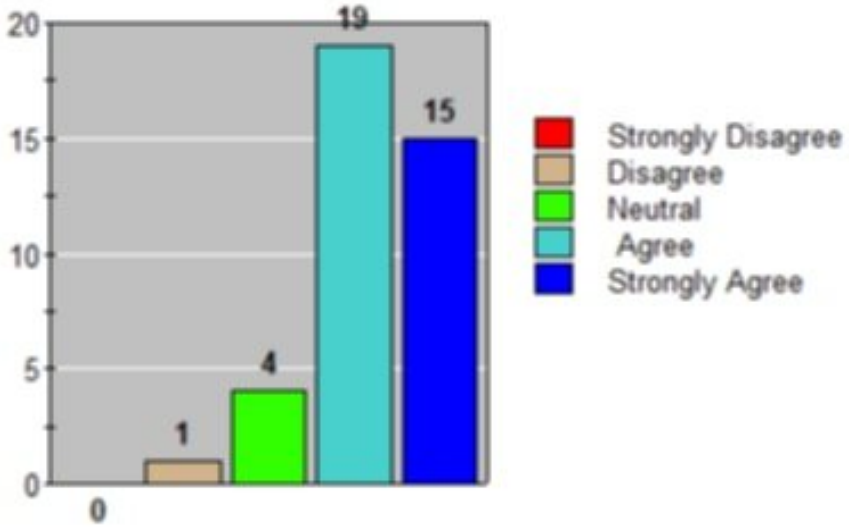


Figure 3.2 shows that the majority of respondents agreed that their overall impression of using natural insecticides than Baygon improved after trying the combination of chili pepper and calamansi. It shows that 19 respondents answered Agree (47%) and 15 respondents Strongly Agree (37%), indicating that most participants developed a more favorable perception of organic insecticides after experiencing their effectiveness. With this, the mean score of the data is 4.21, showing that the overall insights of respondents agreed in terms of improved perception toward natural insecticides. Meanwhile, 4 respondents (10%) answered Neutral, indicating a small portion were still undecided. Only 1 respondent (2%) disagreed and 0 respondents strongly disagreed, showing that negative perception after trying the product was almost nonexistent.

FIGURE 3.3

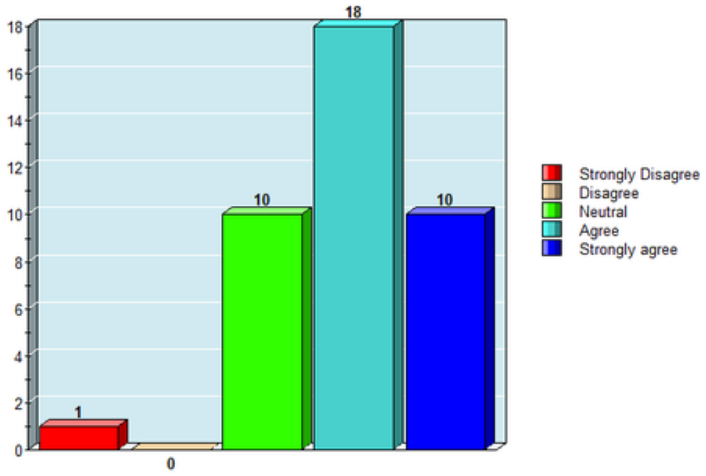


Figure 3.3 shows that the majority of respondents agreed that they are eager to find out more about the advantages of using natural insecticides. It shows that 18 respondents answered Agree (45%) and 10 respondents Strongly Agree (25%), indicating that most participants showed interest in learning more about organic alternatives. With this, the mean score of the data is 3.91, showing that the overall insights of respondents reflect a generally positive curiosity and engagement toward natural insecticides. Meanwhile, 10 respondents (25%) answered Neutral, suggesting that a portion of participants remain undecided. Only 1 respondent (2%) strongly disagreed, and 0 respondents disagreed, indicating very minimal opposition or disinterest.

FIGURE 4.1

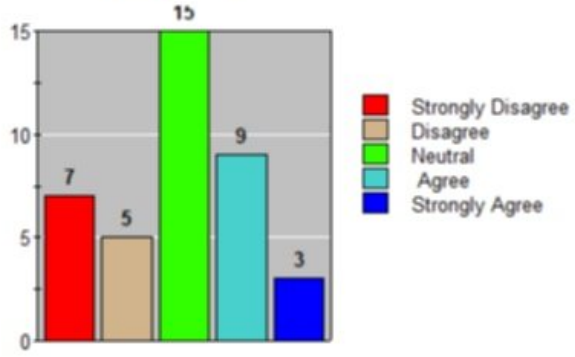


Figure 4.1 shows that the most number of respondents were uncertain that utilizing Baygon positively affects the environment compared to organic insecticides. A total of 15 respondents (37%) answered Neutral, indicating that many participants were unsure of the environmental impact of Baygon. The mean score of the data is 2.84, showing that the overall insights of respondents reflect a lack of strong agreement, leaning slightly toward disagreement regarding Baygon's environmental benefits. 7 respondents (17%) strongly disagreed and 5 respondents (12%) disagreed, suggesting that a significant portion of the participants do not view Baygon as eco-friendly. Only 9 respondents (22%) agreed and 3 respondents (7%) strongly agreed, indicating limited support for Baygon's positive environmental perception.

FIGURE 4.2

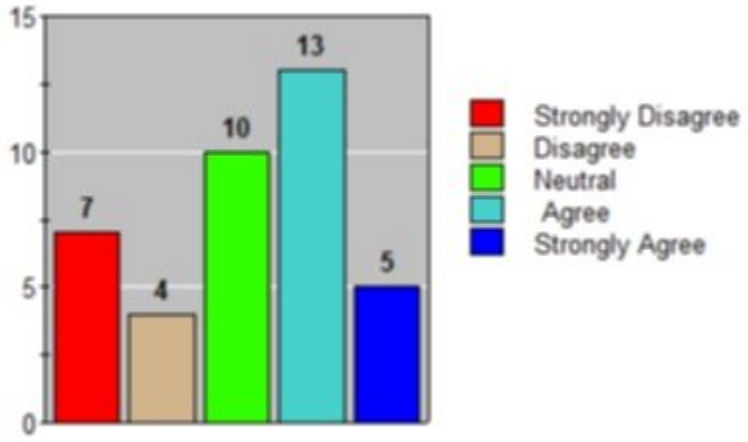


Figure 4.2 shows that the highest number of respondents agreed that their impression of using Baygon improved after trying the research product. It shows that 13 respondents answered Agree (32%), followed by 10 respondents (25%) who answered Neutral, indicating that some respondents had a slightly more favorable view of Baygon, while others remained undecided. With this, the mean score of the data is 3.18, showing that the overall insights of respondents provide a moderate level of agreement, but with a noticeable amount of uncertainty. 5 respondents (12%) answered Strongly Agree, showing a smaller number with a very positive impression, while 4 respondents (10%) disagreed and 7 respondents (17%) strongly disagreed, indicating that a significant portion of the participants were not convinced by Baygon's performance.

FIGURE 4.3

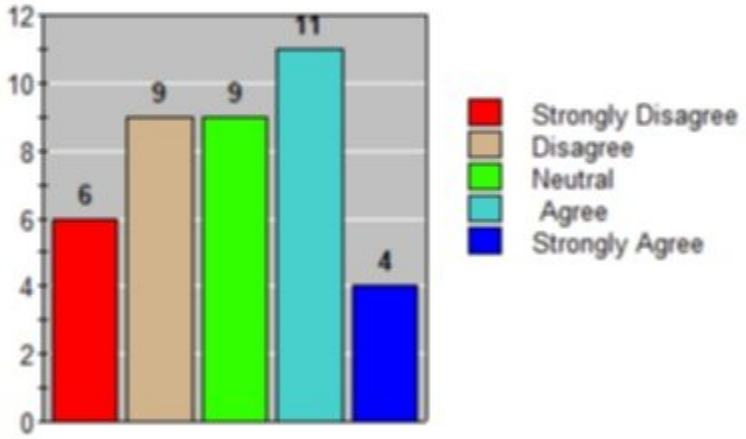


Figure 4.3 shows that the number of respondents is evenly distributed, indicating mixed opinions on whether they are eager to find out more about the advantages of using Baygon. It shows that 9 respondents answered Neutral (22%), indicating uncertainty or lack of strong opinion. Meanwhile, 11 respondents agreed (27%) and 4 respondents strongly agreed (10%), showing that some respondents are interested in learning more about Baygon. With this, the mean score of the data is 3.17, showing that the overall insights of respondents reflect moderate interest, but not a strong eagerness to explore the advantages of Baygon. On the other hand, 9 respondents (22%) disagreed and 6 respondents (15%) strongly disagreed, indicating that a noticeable portion of respondents are not interested in learning more about Baygon.

Statistical Treatment of Data

	Variable 1	Variable 2
Mean	3.996	3.118
Variance	0.09923	0.08957
Observations	5	5
Pearson Correlation	0.762545	
Hypothesized Mean Difference	0	
df	4	
t Stat	9.252877	
P(T<=t) one-tail	0.000379	
t Critical one-tail	2.131847	
P(T<=t) two-tail	0.000759	

A paired sample t-test was conducted to compare the effectiveness levels of two products. The results revealed that Product 1 ($M = 3.996$, $SD = 0.315$) had a significantly higher effectiveness score compared to Product 2 ($M = 3.118$, $SD = 0.299$). The t-test showed a statistically significant difference between the two products, $t(4) = 9.25$, $p < 0.001$, indicating that the observed difference is unlikely to have occurred by chance. These findings suggest that Product 1 is significantly more effective than Product 2, based on the data collected from five paired observations. The strong effect size and low p-value support the conclusion that Product 1 demonstrates superior performance in terms of effectiveness.

	Variable 1	Variable 2
Mean	4.06	3.03
Variance	0.0392	0.0162
Observations	2	2
Pearson Correlation	1	
Hypothesized Mean Difference	0	
df	1	
t Stat	20.6	
P(T<=t) one tail	0.01543981591	

t Critical one tail	6.313751515	
P(<=t) two tail	0.03087963182	
t Critical two tail	12.70620474	

A paired samples t-test was conducted to compare the effectiveness of two products in terms of environmental and consumer perception of both products. The results showed that Product 1 (M = 4.06) had a higher effectiveness rating than Product 2 (M = 3.03). Despite the very small sample size (n = 2 per group), the difference was statistically significant, t(1) = 20.6, p = 0.031.

4.2 BRIEF DISCUSSION

The survey questionnaires suggested that the organic insecticide produced from combined extracts with 70% *capsaicin* and 30% calamansi concentration yielded higher effectivity, even in comparison with the considered *Product X* (*Baygon*). The majority of respondents' answers also point to its usability and sustainability as a possible commercially-created product. With this, the alternative hypothesis was also concluded to have significant results when it comes to killing *P. americana* based on the experimental results.

CHAPTER 5: CONCLUSION & RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The experimental study on the effectiveness of *Capsicum frutescens* (pepper) and *Citrofortunella microcarpa* (calamansi) extracts as alternative organic insecticides against *Periplaneta americana* (American cockroach) yielded promising results. Both extracts demonstrated significant insecticidal properties, with mortality rates increasing in correlation with higher concentrations of the extracts. *Capsicum frutescens* exhibited a stronger insecticidal effect compared to *Citrofortunella microcarpa*, and the combination of both extracts revealed a synergistic effect that enhanced their overall effectiveness. Active compounds such as capsaicin in *Capsicum frutescens* were identified as key contributors to its insecticidal activity, while *Citrofortunella microcarpa* may disrupt the cockroach's nervous system or deter feeding. The findings suggest that these natural extracts could serve as viable alternatives to synthetic insecticides, promoting sustainable pest control practices.

5.2 CONCLUSION

The study was to delve deeper to the efficacy of *Capsicum frutescens* (chili pepper) and *Citrofortunella microcarpa* (calamansi) extracts as an alternative organic insecticide against *Periplaneta americana* (American cockroach) to see if natural extracts could be beneficial in the development of environmentally sustainable and safer alternatives to commercial insecticides.

The combined extracts showed that it can effectively kill insects which is good news for consumers as it is a natural pesticide. Of course, though the organic formulation worked well it wasn't quite as potent as synthetic insecticides such as *Baygon Roach Killer.* The study suggests that organic insecticides can be a better and healthier option.

Furthermore the results have brought issues such as adverse effects (the strong and unpleasant smell of the chili and calamansi) suggests that strategies should be focused on enhancement of the formulation so that it will become acceptable for consumers without any adverse effects on insect activity. The findings also offer more investigation in practical conditions (in households and in restaurants) and the consideration of other plant-based compounds that possess effective insecticidal properties.

Organic insecticides such as the combination of *Capsicum frutescens* and *Citrofortunella microcarpa* are promising and deserve further research and improved formulation to become viable and accepted alternatives to synthetic chemical insecticides.

5.3 RECOMMENDATIONS

The following recommendations are offered as possible ways to improve the study. These recommendations are suggested by researchers to effectively use organic insecticide and to not harm the environment.

- To confirm the effectiveness in actual household or commercial settings, it is recommended to conduct experiments in homes, kitchen areas, or restaurants where cockroaches are commonly found.

- It is recommended to use the *Baygon Roach Killer Spray* as it targets cockroaches specifically. Other sprays like perfume sprays give out more and more liquid that will release into the air and reach the noses of folks around you.

The following recommendations are offered for practitioners in the field of science and future researchers to improve the quality of the organic insecticides.

- This study primarily evaluated the insecticidal properties of *Capsicum frutescens* and *Citrofortunella microcarpa* against *Periplaneta americana.* Future research could expand on this by testing the formulation on other insect species to determine whether its effectiveness extends beyond cockroaches. Investigating its impact on pests such as ants or mosquitoes could provide insight into its broader potential as a natural insecticide.

- Further studies could also focus on refining the formulation. One of the key findings was that the strong odor of the extract was a significant drawback. Research could explore ways to modify the formulation to make the scent more tolerable while maintaining its insecticidal properties. This could involve testing alternative plant-based extracts with similar pest-killing effects but a milder aroma.

- Another important aspect to consider is the long-term impact of this organic insecticide. Future research could examine whether continuous exposure leads to resistance in cockroach populations or if there are any unintended ecological effects, such as its influence on non-target insects beneficial to the environment.

- Finally, conducting trials in real-world environments, such as households, kitchens, and commercial establishments, would provide valuable insights. While this study gathered

essential data, testing the insecticide in actual infestation-prone settings could further validate its practical application and effectiveness.

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