

Neem (*Azadirachta indica*), soursop (*Annona muricata*), and tsaang-gubat (*Carmona retusa*) leaves as a biopesticide for pechay (*Brassica rapa*) plants

Santos, Matthea Andrina G. ✉

Divine Word College of San Jose, Philippines (Santosmatthea19@gmail.com)

Mangabat, Daniella C.

Jugao, Hannah Shae G.

Dela Cruz, Agatha Nillyze O.

Alvarado, Amerie Lyonne A.

Bacorro, King Alfred G.

Ortega, Khenn Ivan C.

Bautista, Josephine N.

Galay-Limos, Jenny A.

Rodil, Maria Victoria B.



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Abstract

This study examined the efficacy of a plant-based biopesticide formulated from the leaves of tsaang-gubat (*Carmona retusa*), Neem (*Azadirachta indica*), and soursop (*Annona muricata*) in managing pests threatening pechay (*Brassica rapa*) plants. This research was designed to assess how different levels of a biopesticide formulation may reduce pest-induced crop loss (such as wilted leaf area and pest feeding) and to identify the most effective level for this purpose. A quantitative true experimental design was used, in which the experimental groups received various biopesticide formulations, while the control group received water. During the establishment growth period, the plants were monitored, and information on insect activity and plant health was methodically documented and examined. The results showed that the formulated biopesticide at higher concentrations reduced insect damage and leaf withering more effectively than the control group and lower concentrations. The results show that the combination of these plant extracts has a significant impact as a natural and eco-friendly substitute for synthetic pesticides. By using locally available plant resources, the study promotes sustainable farming methods and provides small-scale farmers with an affordable pest management option. The study shows that plant-based biopesticides can effectively protect crops while reducing the environmental and human health impacts of synthetic pesticides.

Keywords: biopesticide, pest control, pechay, neem, soursop, tsaang-gubat

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1. Introduction

Farmers work hard to grow our food, but pests cause significant damage to pechay crops, resulting in substantial agricultural losses. Therefore, finding effective, sustainable pest control solutions is essential to reducing farmers' dependence on synthetic pesticides. As advocates of sustainable agriculture, they have observed that many people are interested in plant-based biopesticides because they are less harmful to the environment and safer for farmers and consumers alike. When large numbers of pests attack, they cause extensive crop damage (Mawcha et al., 2024). This means farmers receive less food to sell, and the quality of their harvest results in lower income. For decades, farming has often relied on synthetic pesticides to kill pests (Bakker et al., 2020). However, they provide quick help that often hides their many problems, making them not the best choice for long-lasting pest control. Moreover, these pesticides can harm the environment by polluting soil and water and pose a threat to the health of people and animals. Farmers with small-scale plantations often face major challenges due to limited financial resources. This situation makes it hard for them to access or afford safer pest-control options. A study by Ayilara et al. (2023) noted that, despite the development of synthetic pesticides, farmers around the world still struggle to control pests and protect crops. Concerns about the health, environmental, and resistance risks posed by synthetic chemicals are driving a shift toward biopesticides as a safer, more sustainable choice.

Many studies suggest that Neem (*Azadirachta indica*) is a highly viable and ecologically sensitive botanical pesticide because its extracts modify the feeding, growth, and reproduction of insect pests without causing toxicity to humans or the environment. The main component of Neem, Azadirachtin, acts as an antifeedant, repellent, and growth disruptor (Muhammad & Kashere, 2021). These findings highlight the potential of botanical pesticides to make farming systems more resilient while protecting both crops and natural ecosystems. Despite extensive prior efforts, there remains a significant need to study and validate the effectiveness of natural pest control methods. These methods must be easy to use, affordable for small-scale farmers, and made from readily available local resources. Unfortunately, many natural solutions currently available are either too complicated to produce, too expensive, or harmful to all farmers (Daneti, 2024). To address this gap, this study aimed to investigate a new natural pesticide that was derived from the leaves of Soursop (*Annona muricata*), Neem (*Azadirachta indica*), and Tsaang-gubat (*Carmona retusa*), all of which are local sources. To address this gap, this product is valuable because it relies on easily accessible plants. It provides a more affordable alternative to chemical pesticides and promotes eco-friendly farming by cutting down the need for harmful chemicals.

The main goal of this research is to formulate and evaluate the effectiveness of Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) in eliminating pests on pechay crops. This objective helped develop a farming method that is both sustainable and resilient against pests. Such new methods improved crop safety, leading to larger harvests while reducing the environmental damage usually caused by pest control. Additionally, this research aims to develop and test a biopesticide that significantly reduces pest infestations in pechay crops.

Statement of the Problem - This study determined the effectiveness of Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) leaves as biopesticides against pests of pechay crops. Specifically, it sought to answer the following questions: (1) What is the level of effectiveness of the formulated biopesticide for Pechay plants in terms of the number of withered leaves and the number of feeding damage? (2) What biopesticide concentration is the most effective in reducing pest population and feeding damage? (3) Does the biopesticide concentration affect its effectiveness in reducing pest population and feeding damage? (4) Is there a significant difference between the Pechay plants planted in the treatment and control groups in terms of the

number of withered leaves and the number of feeding damages?

Statement of Hypothesis - This study aimed to test the given hypothesis: H01: The biopesticide concentration does not affect its effectiveness in reducing pest population and feeding damage. H02: There is no significant difference between the Pechay plants planted in the treatment and control groups in terms of the number of withered leaves and the number of feeding damages.

Significance of the Study - This experimental research focused on formulating and testing an environmentally friendly biopesticide to manage pest infestations in pechay crops. The study highlighted the importance of sustainable pest management practices that safeguard the health of consumers and farmers while reducing farmers' dependence on harmful synthetic pesticides. This innovative concept not only helps protect the environment, but it also makes farming more productive and food safer. This study provides practical benefits to the following sectors: First, farmers. It would help by providing an affordable, natural biopesticide using Tsaang-gubat, Soursop, and Neem leaves. It may reduce crop damage from pests and lessen their reliance on chemical pesticides, which can be harmful to human health and the environment. Second, for the Local Government Units (LGUs), this study would help them promote the use of organic and environmentally friendly alternatives to chemical pesticides. It may also guide them in creating programs that support sustainable agriculture and help local farmers protect their crops more safely and naturally. Third, it is for environmentalists who may benefit from this study, as it encourages organic solutions to pest problems in farming. The research promotes reducing the use of chemicals in agriculture. It helps protect the environment, and the results of this study may serve as a reference for agricultural technicians in recommending safe and effective pest control methods. It also helps them develop strategies that focus on using the local natural resources. Lastly, the study conducted would further open the door for future researchers to refine and expand studies on biopesticides and sustainable agriculture. This may serve as a useful source of information in developing new organic pest control products.

Scope and Delimitation of the Study - This study assessed the effectiveness of a biopesticide formulated from Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) leaves against pests infesting pechay crops. The experiment measured the effects of both the formulated biopesticide and control treatment on pests in terms of locomotor activity, mortality rate, and plant condition. The research area was in a well-controlled backyard environment in Camburay, San Jose, Occidental Mindoro. The experimental phase spanned from August 2025 through February 2026. This time frame included planning and preparation for the experiment, planting the pechay seeds, making the treatments (i.e., preparing the solution), applying the treatments, observing the effects on the plants, collecting data, and analyzing the results. The experiment included 96 pechay plants, evenly distributed across four plot areas. Each plot area had 24 pechay seedlings. The treatments tested in this study were formulated using 150g of plant matter per liter of water to create three distinct concentrations. Concentration 1 was composed of 120g of Neem, 15g of Guyabano, and 15g of Tsaang-gubat. Concentration 2 was made up of 105g of Neem, 30g of Guyabano, and 15g of Tsaang-gubat. Concentration 3 was made of 105g of Neem, 15g of Guyabano, and 30g of Tsaang-gubat. These specific proportions were selected based on available resources to assess the efficacy of doubling the secondary ingredients compared with a standard Neem-heavy foundation. A fourth plot containing 24 seedlings served as the control group and received only water to establish a baseline for comparison with the treatment groups.

2. Methodology

Research Design - This study used a true experimental research design to evaluate the effectiveness of a plant-based biopesticide made from the leaves of Tsaang-gubat (*Carmona retusa*), Soursop (*Annona muricata*), and Neem (*Azadirachta indica*) against pests infesting pechay crops. The experimental research design ensured that each treatment was randomly assigned to experimental units to avoid bias and maintain reliability, making it suitable for trials with a small number of treatments (Berger et al., 2021). According to an article by Strba (2024), the main goal of evaluation research is to assess a product's overall coverage of hidden issues and potential areas for improvement, thereby enhancing user experience. It is an excellent method for confirming the ideas that have

already been developed. Four (4) plots are used in the experiment: three (3) treatment plots and one (1) untreated plot that acts as the control group. Concentration 1 contains 15 g of guyabano leaves, 15 g of tsaang-gubat leaves, and 120 g of neem leaves; Concentration 2 contains 30 g of guyabano leaves, 15 g of tsaang-gubat leaves, and 105 g of neem leaves; and Concentration 3 contains 15 g of guyabano leaves, 30 g of tsaang-gubat leaves, and 105 g of neem leaves. In each treatment plot, a different concentration of the biopesticide is applied. To assess variations in pest control effectiveness, this configuration enables consistent replication and reliable comparison between treated and untreated plots. From planting to harvest, the experiment lasted for one (1) month and one (1) week.

Data Gathering Procedure - Through a series of experiments and observations during the formulation process, the researchers assess the effectiveness of the biopesticide made from the leaves of Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*). The testing was carried out in a controlled garden area to guarantee consistent ambient conditions and accurate field conditions. The entire experimental process lasted for one month and one week, which served as the estimated duration from planting to harvest of the pechay crop. During the experiment, different concentrations of the formulated plant extracts were sprayed on pechay plants infested with pests. Regular observations were conducted, and findings were documented, including the level of feeding damage on the leaves and the overall condition and vigor of the pechay plants. All findings are carefully documented using observation sheets and supported with photographic evidence. The collected data were organized and analyzed using Analysis of Variance (ANOVA) to assess the efficacy of each biopesticide concentration in managing pests and improving pechay plant health.

Research Process

Stage 1 Preparation and Gathering of Materials - The materials needed to formulate the plant-based biopesticide using Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) leaves include the plant materials and the pechay plants that served as test subjects. Fresh leaves of the three plant species were collected from local areas in San Jose, Occidental Mindoro. Pechay plants naturally infested with pests are prepared for the experiment to assess the effectiveness of the biopesticide treatments. Several tools and pieces of equipment are required for preparing the leaf extracts. These include scissors or pruning shears for collecting leaves, plastic containers or bags for transporting them, and clean water with basins for washing. Drying trays or a clean cloth were used for air-drying, while a food processor was used to crush the leaves. Measuring cups or weighing scales ensured consistent amounts of plant materials, while clean jars or bottles served as containers for soaking the leaves. Filter cloth or strainers help separate the liquid extract. Additional materials include spray bottles for applying the extract, markers and labels for identifying treatments, and protective gear such as gloves and face masks. For research documentation, a field observation sheet or logbook was prepared to record the number of visible pests, signs of feeding damage, and the general condition of the pechay plants before and after treatment. A mobile phone camera is also used to take photo evidence during each observation. All materials are obtained from common household or agricultural supplies, ensuring the experiment remains practical, accessible, and easy to replicate.

Stage 2: Building and Development of the Project - The development of the biopesticide began with the collection and preparation of the plant materials. Fresh leaves of Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) are gathered from local areas in San Jose, Occidental Mindoro. For the first five (5) days, leaves from the three plants were washed and air-dried in the shade to protect their active compounds from sun damage. On the sixth (6) day, the dried leaves were ground into a powder and soaked in water. Finally, the mixtures were filtered through a cloth to collect the liquid extracts. The extracts were then combined according to the required concentrations and placed in properly labeled containers to ensure accurate identification and consistency.

The researchers prepared different concentrations by combining varying amounts of guyabano, tsaang-gubat, and neem leaf extracts to determine which formulation is most effective in protecting pechay crops against common pests. Four (4) plots are used in the experiment: three (3) treatment plots and one (1) control group plot.

Concentration 1 consists of 15 g of guyabano leaves, 15 g of tsaang-gubat leaves, and 120 g of neem leaves. 30 g of guyabano leaves, 15 g of tsaang-gubat leaves, and 105 g of neem leaves make up Concentration 2, whereas 15 g of guyabano leaves, 30 g of tsaang-gubat leaves, and 105 g of neem leaves make up Concentration 3. To ensure precise identification and uniformity throughout the experiment, and to prevent mold growth, these solutions are placed in sterile, appropriately labeled containers. During preparation, careful observation is conducted to monitor any changes in color, texture, or appearance that may indicate the stability and quality of the mixtures. This stage is essential for developing a safe, natural biopesticide from locally available plants. The successful formulation demonstrates that simple methods can produce an environmentally friendly pest control solution, offering pechay farmers an affordable alternative to harmful synthetic pesticides.

Statistical Treatment of the Data - Descriptive and inferential statistical methods were used to analyze the data gathered from the experimental treatments. The number of withered leaves and the degree of feeding damage seen in each treatment group and the control group were summarized using descriptive statistics, especially the mean. These values enabled comparison of insect damage across various biopesticide concentrations and helped determine which treatment provided pechay plants the best protection. Analysis of Variance (ANOVA) was used at a significance threshold of 0.05 to ascertain whether the observed differences between treatment concentrations and the control group were statistically significant. The investigation showed that treated plants had lower mean values for feeding damage and leaf withering than the control group, indicating improved plant protection. Additionally, variations in concentration were noted, indicating that the biopesticide's efficacy depended on the concentration used. Overall, the statistical analysis confirmed that the developed pesticide greatly reduced the damage to pechay plants.

Ethical Considerations - The researchers ensured that all research procedures were conducted responsibly and safely within a controlled environment, prioritizing fairness, environmental care, and respect for all stakeholders. The collection of tsaang-gubat leaves, soursop leaves, and neem leaves would be conducted sustainably without harming the trees and plants used. All waste generated after the extraction process would be disposed of appropriately. The preparation and administration of the biopesticide would adhere to strict safety protocols, including the use of protective gear such as gloves. They would be conducted only in designated plots to prevent unexpected events. The study would comply with the rules and policies of the Divine Word College of San Jose, as well as local environmental and agricultural regulations. All data gathered are recorded accurately and honestly, used solely for research purposes, and all findings are reported transparently. Throughout the study, the researchers would discuss the core values of being a Divinian—integrity, service, and competence—while ensuring sustainability and adherence to the No Harm Principle.

1. Results and Discussions

Table 1

Mean level of effectiveness of the formulated biopesticide for Pechay plants in terms of Withered Leaves

Treatments	Weighted Mean (Number of withered leaves)	Standard Deviation (Number of withered leaves)	Standard Error (Number of withered leaves)	Verbal Description
Control Group	10.47	4.78	0.32	Moderately Effective
Concentration 1: 15g of Tsaang-gubat 15g of Guyabano 120g of Neem	15.00	8.83	2.28	Least Effective
Concentration 2: 15g of Tsaang-gubat 30g of Guyabano 105g of Neem	2.07	2.40	0.62	Highly Effective

Concentration 3: 30g of Tsaang-gubat 15g of Guyabano 105g of Neem	1.60	2.03	0.14	Highly Effective
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Legend: 1.60 – 6.07 Highly Effective, 6.08 – 10.54 Moderately Effective, 10.55 – 15.00 Least Effective

Table 1 presents the effects of varying concentrations of the biopesticide formulated from neem (*Azadirachta indica*), soursop (*Annona muricata*), and tsaang-gubat (*Carmona retusa*) leaves on leaf withering of pechay (*Brassica rapa*) plants. The results indicate that the number of wilted leaves decreased as biopesticide concentration increased. The least effective was Concentration 1, which had the highest mean number of withered leaves (15.00), while Concentration 2 and Concentration 3 had lower means of 2.07 and 1.60, respectively. These findings suggest that the biopesticide formulation can reduce leaf withering, and higher doses generally provided superior protection, with Concentration 3 showing the highest efficacy. In addition, the standard deviation (SD) and standard error (SE) were also computed to measure the variability and reliability of the data. The calculated SE values were 0.32, 2.28, 0.62, and 0.14, and the SD values were 4.78, 8.83, 2.40, and 2.03. Concentrations 2 and 3's comparatively lower estimated SD values imply that these treatments were more consistent than those of other concentrations.

Interestingly, some crumpling and wilting were observed in plants in Concentration 1, indicating that it was too strong and caused high stress. Compared with the Control Group (mean 10.47), the overall mean across the treatment groups is significantly lower. The success of the plant-based treatment in preserving plant health is demonstrated by the fact that untreated plants showed more leaf withering than those treated with the prepared biopesticide. Furthermore, this suggests that when used at an effective concentration, the developed biopesticide can help mitigate pest-induced stress. Previous studies on botanical biopesticides support these results. Neem extracts, particularly azadirachtin, act as antifeedants and insect growth regulators, reducing herbivory and promoting healthier foliage in vegetable crops (Modal & Modal, 2012). According to Syafi'ah et al. (2025), the leaf extract of soursop contains compounds such as acetogenins and flavonoids that deter pest feeding and reduce damage to cruciferous vegetables, thereby demonstrating its potential to safeguard pechay plants. Tsaang-gubat leaves are also rich in secondary metabolites, such as tannins and flavonoids, which deter insect pests and minimize plant damage (Salas & Totaan, 2015). Together, these findings validate the effectiveness of these plant-based biopesticides in reducing leaf withering and maintaining overall plant health.

Table 2

Mean level of effectiveness of the formulated biopesticide for Pechay plants in terms of feeding Damage

Treatments	Weighted Mean (Number of feeding damage)	Standard Deviation (Number of feeding damage)	Standard Error (Number of feeding damage)	Verbal Description
Control Group	39.27	14.21	0.95	Least Effective
Concentration 1: 15g of Tsaang-gubat 15g of Guyabano 120g of Neem	27.67	11.22	2.90	Least Effective
Concentration 2: 15g of Tsaang-gubat 30g of Guyabano 105g of Neem	7.20	4.16	1.07	Highly Effective
Concentration 3: 30g of Tsaang-gubat 15g of Guyabano 105g of Neem	14.60	3.27	0.22	Highly Effective

Legend: 7.20 – 17.89 Highly Effective, 17.90 – 28.58 Moderately Effective, 28.59 – 39.27 Least Effective

Table 2 shows that, across treatment concentrations, the results indicate feeding harm. Among the treated groups, Concentration 1 had the lowest level of protection, with the largest mean feeding damage (27.67). The mean feeding damage for Concentration 2 was the lowest at 7.20, but the mean for Concentration 3 was 14.60. In addition to computing the mean, measures such as the standard deviation were calculated to assess the observations within each treatment group. Reporting the standard deviation allowed the researcher to examine the consistency of the results and the variability of plant response within each treatment. Furthermore, the calculated standard deviations of damage were 14.21, 11.22, 4.16, and 3.27, and the equivalent corresponding groups' standard error values were 2.90, 1.07, and 0.22. While the smaller values in other treatments imply more consistent observations, the larger values in other treatments indicate greater heterogeneity in the number of feeding damage. The mean feeding damage values provide accurate assessments of the treatment impacts on the affected plants, as indicated by the relatively small error values.

For all treatment groups, the calculated overall mean was 16.49. The control group, on the other hand, had a significantly higher mean of 39.27, indicating significantly more feeding damage among untreated plants. These results show that the biopesticide's formulation successfully lessens pest-induced feeding damage. Concentration 2 showed the greatest degree of efficacy in reducing feeding damage among the treatment groups. This suggests that a balanced plant-based biopesticide can reduce crop loss. The successful use of plant extracts as efficient biological pest management agents was confirmed by experimental studies employing various botanical extracts, such as neem and other plant-derived formulations, which showed notable decreases in pest activity and plant damage compared to untreated controls (Kamanga et al., 2025).

Table 3

The most effective concentration in reducing pest population and feeding damage

Treatments	Withered Leaves Mean	Feeding Damage Mean	Total Mean	Verbal Description	Rank
Concentration 1: 15g of Tsaang-gubat 15g of Guyabano 120g of Neem	15.00	27.67	42.67	Least Effective	3
Concentration 2: 15g of Tsaang-gubat 30g of Guyabano 105g of Neem	2.07	7.20	9.27	Highly Effective	1
Concentration 3: 30g of Tsaang-gubat 15g of Guyabano 105g of Neem	1.60	14.60	16.20	Highly Effective	2

Legend: 9.27 – 20.40 Highly Effective, 20.41 – 31.54 Moderately Effective, 31.55 – 42.67 Least Effective

Table 3 shows that the study's results indicate that the biopesticide's effectiveness varies by the metric measured. Concentration 3 was the most effective in reducing the number of withered leaves, while Concentration 2 produced the lowest feeding damage, suggesting that it was the most effective in reducing pest activity. Since feeding damage directly reflects insect presence and behavior, Concentration 2 may be considered the most effective treatment overall in suppressing pest population and feeding activity. Therefore, this implies a proper ratio of plant extract components is more important than simply increasing concentrations in enhancing pest control effectiveness. The neem compounds can act as repellents, feeding inhibitors, and growth regulators, which explains why treatments containing plant extracts can significantly reduce pest damage compared to untreated plants (Chaudhary et al., 2017). These mechanisms help clarify why the present study observed a substantial decrease in feeding damage under Concentration 2, indicating that the bioactive compounds in the

formulation effectively interfered with insect feeding behavior.

Table 4*ANOVA Result for Withered Leaves*

SUMMARY								
Groups	Count	Sum	Average	Variance				
CONCENTRATION 1	15	225	15	78				
CONCENTRATION 2	15	31	2.066667	5.780952				
CONCENTRATION 3	15	24	1.6	4.114286				

ANOVA								
Source of Variation	SS	df	MS	F	P-value	F crit	Significance	
Between Groups	1735.244	2	867.6222	29.61328	≤0.001	3.219942	Highly significant	
Within Groups	1230.533	42	29.29841					
Total		44						

Legend: Highly Significant at $p \leq 0.001$ and Significant at $p \leq 0.05$

Table 4 shows the One-Way Analysis of Variance (ANOVA) results for the number of withered leaves among the three concentrations of the formulated biopesticide made from Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*). The computed F-value (29.61328) is significantly higher than the F critical value (3.219942), and the p-value (≤ 0.001) is less than the 0.05 level of significance. This suggests that the number of withering leaves varied statistically significantly between the treatment groups. The results show that variations in extract concentration significantly affected the efficacy of plant protection. As a result, the null hypothesis—which claims that the concentration of biopesticides has no discernible impact on the quantity of withered leaves—is rejected. This study supports Isman's (2020) findings, asserting that neem contains azadirachtin, a bioactive molecule that inhibits insect growth and feeding behavior, thereby reducing plant damage. Among the treatments, Concentration 3 recorded the lowest mean number of withering leaves, followed by Concentration 2, while Concentration 1 showed the highest mean.

Table 5*ANOVA Result for feeding damage*

SUMMARY								
Groups	Count	Sum	Average	Variance				
CONCENTRATION 1	15	415	27.66667	125.9524				
CONCENTRATION 2	15	108	7.2	17.31429				
CONCENTRATION 3	15	219	14.6	10.68571				

ANOVA								
Source of Variation	SS	df	MS	F	P-value	F crit	Significance	
Between Groups	3221.911	2	1610.956	31.39196	$p \leq 0.001$	3.219942	Significant	
Within Groups	2155.333	42	51.31746					
Total		44						

Legend: *Highly Significant at $p \leq 0.001$ *Significant at $p \leq 0.05$

The results in Table 5 indicate no difference in feeding damage across the different biopesticide

concentrations. The computed F-value (31.39196) is higher than the critical value (3.219942). Moreover, the computed p-value (≤ 0.001) is well below the 0.05 significance level. Since the p-value (≤ 0.001) is less than 0.05, there is a statistically significant difference among the treatment groups in feeding damage. As a result, the null hypothesis, which holds that the concentration of biopesticides has no discernible impact on feeding damage, is rejected.

With a mean of 7.20, Concentration 2 has the lowest feeding damage of all the elements, followed by Concentration 3 with a mean of 14.60 and Concentration 1 with the highest mean of 27.67. These findings support the idea that properly balanced plant extracts can effectively reduce pest activity. This result aligns with the study by Ayilara et al. (2023), which found that foundant-b biopesticides are effective in controlling agricultural pests while minimizing environmental risks. Similarly, López and Pascual-Villalobos (2021) stated that higher-performing botanical formulations significantly reduce pest damage depending on concentration and exposure. The lower feeding damage observed in Concentration 2 may be attributed to the combined insecticidal and antifeedant properties of Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*), which contain bioactive compounds such as azadirachtin, acetogenins, flavonoids, and tannins. According to Chaudhary et al. (2017) and Muhammad & Kashere (2020). Azadirachtin disrupts insect feeding and growth, while Ningrum (2023) found that soursop extracts significantly reduce pest infestation and leaf damage. The data in Table 4 indicate that the concentration of the formulated biopesticide is essential for reducing pest feeding damage on pechay plants and that the ideal mixture of plant extracts improves effectiveness.

Table 6

Significant difference between the Pechay plants planted in the Treatment and Control Group in the number of withered leaves

t-Test: Two-Sample Assuming Equal Variances		
	CONTROL GROUP	CONCENTRATION 2
Mean	10.4667	2.0667
Variance	22.8381	5.7810
Observations	15	15
Pooled Variance	14.3095	
Hypothesized Mean Difference	0	
df	28	
t Stat	6.0813	
P(T<=t) one-tail	7.35443E-07	
t Critical one-tailed	1.7011	
P(T<=t) two-tail	1.47089E-06	
t Critical two-tailed	2.0484	

Legend: *Highly Significant at $p \leq 0.001$ *Significant at $p \leq 0.05$

According to Table 6, the Control Group had a high mean number of wilted leaves (10.47), while Concentration 2, the most successful treatment, had a mean of just 2.07. The P-value (1.47×10^{-6}) was less than the 0.05 significance level, while the computed t-statistic (6.08) was more than the crucial value (2.05). The rejection of the null hypothesis of no difference thus supported the finding that the biopesticide considerably reduced leaf withering, consistent with more extensive studies showing that certain biopesticide treatments can significantly reduce pest-induced visible plant damage. The general trend indicates that biologically derived pest management products can result in quantifiable reductions in herbivore-induced plant symptoms compared to untreated controls, despite variations in technique and target species. In a screening of botanical and microbial biopesticides against *Spodoptera frugiperda* in maize, extracts reduced pest population and associated damage severity by nearly 47 % compared to untreated fields, with significant herbivory suppression evident in treated

plots (Sulastri et al., 2025).

Table 7

Significant difference between the Pechay plants planted in the Treatment and Control Groups in the number of feeding damage.

t-Test: Two-Sample Assuming Equal Variances		
	CONTROL GROUP	CONCENTRATION 2
Mean	39.2667	7.2
Variance	201.7810	17.3143
Observations	15	15
Pooled Variance	109.5476	
Hypothesized Mean Difference	0	
df	28	
t Stat	8.3904	
P(T<=t) one-tail	1.99033E-09	
t Critical one-tailed	1.7011	
P(T<=t) two-tail	3.98065E-09	
t Critical two-tailed	2.0484	

Legend *Highly Significant at $p \leq 0.001$ *Significant at $p \leq 0.05$

The feeding damage is shown in Table 7 and showed a similar pattern: Concentration 2 had a mean of only 7.20, whereas the Control Group had a mean of 39.27. A highly significant difference was confirmed by the t-statistic (8.39) and P-value (3.98×10^{-1}), suggesting that the biopesticide significantly reduced insect feeding activity. These results imply that the microbial agents or bioactive substances in the biopesticide formulation effectively reduced pest feeding behavior. The plant-based biopesticide's potential to reduce feeding damage is supported by reports of similar decreases in pest feeding activity for botanical extracts of *Annona muricata* (soursop), whose acetogenins and flavonoids act as antifeedants and inhibitors of larval development on Brassica hosts (Ramadan & Yuliani, 2025).

3. Conclusions

Based on the findings of the study, the following conclusions were drawn: The formulated biopesticide made from Neem (*Azadirachta indica*), Soursop (*Annona muricata*), and Tsaang-gubat (*Carmona retusa*) is effective in reducing withered leaves and feeding damage in pechay (*Brassica rapa*) plants. Concentration significantly influences the effectiveness of the biopesticide. Higher or properly balanced concentrations resulted in greater pest control. Concentration 3 was the most effective in minimizing withered leaves, while Concentration 2 was the most effective in reducing feeding damage. The effectiveness of the biopesticide varied depending on the concentration used. Concentration has a significant influence on the formulated biopesticide, as evidenced by the decreasing degrees of reduction in insect feeding and plant damage across different concentrations. The Pechay plants planted in the treatment and control groups differed significantly. The treatment and control groups differed significantly from one another. Compared to untreated plants, plants treated with the biopesticide exhibited fewer withered leaves, indicating that the treatment successfully reduced pest-caused damage, and the control groups differed significantly from one another. The efficiency of the formulated biopesticide in reducing insect feeding activity was confirmed by significantly lower damage observed in insects compared with the control group.

Recommendations - Based on the study's findings, farmers are encouraged to use plant-based biopesticides derived from neem, soursop, and tsaang-gubat leaves as a safer, affordable, and eco-friendly alternative to conventional pesticides. Community-based farming groups may promote the preparation and use of natural biopesticides using locally available plant resources to support sustainable agricultural practices. Senior high

school and college students may replicate or enhance this study by testing additional plant combinations, different concentration levels, or other vegetable crops to broaden research on natural pest control methods. Agricultural professionals may utilize the findings of this study as a reference in recommending eco-friendly pest control ideas to local farmers. They advise future researchers to conduct a similar study to address certain areas for improvement. For instance, they may examine the long-term effects of the biopesticide on plant growth, crop yield, soil health, and beneficial organisms. Additionally, researchers are encouraged to refine concentration levels to maximize pest control while preventing possible stresses or phytotoxic effects.

4. References

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