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Research Article

Evaluating the Efficacy of *Dieffenbachia picta* (Araceae) Leaves Insecticidal Activity Against *Cimex lectularius* in Arba Minch Town

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Abstract

The common bed bug, Cimex lectularius, is an age-old human parasite. Recognizing bed bugs as a significant public health concern, the Environmental Protection Agency highlights the need for effective strategies to address infestations and protect people's well-being. Therefore, the aim of this investigation was to evaluate the efficacy of *Dieffenbachia picta* leaf extracts against bedbugs under laboratory conditions. Insecticidal bio-assay and phytochemical analysis were performed using topical methods and a qualitative analytical protocol. This study demonstrated that extracts obtained from the dumb cane plant using various solvents (methanol, ethanol, distilled water, and acetone) exhibited significant insecticidal activity against bedbugs. Among the solvent extracts, the methanol extract showed a 100% mortality rate, the ethanol extract showed 80%, the acetone extract showed 80%, and the distilled water extract showed 70% mortality at a concentration of 1g/l. A mixture experimental design was used to investigate how the formulation components of the solvent extracts (methanol, ethanol, acetone, and distilled water) affected the synergistic effect and mortality rate. It was found that a combination of 25% methanol, 30% ethanol, 25% acetone, and 20% distilled water effectively demonstrated the optimal synergistic effect of the extracts against bedbug spp. In conclusion, this study demonstrates that extracts from *Dieffenbachia picta* have the potential to serve as a natural solution for controlling bedbugs.

Keywords

Bedbug, *Dieffenbachia picta*, Insecticidal Activity

1. Introduction

The common bed bug, *Cimex lectularius*, is a human parasite that has been in existence for thousands of years [1]. Bed bugs are wingless, oval-shaped, flat, reddish-brown insects that grow to an adult length of approximately 5 mm [1, 2]. They resemble small cockroaches or unfed ticks. During the day, bed bugs hide in cracks found in beds, furniture, flooring, and walls [2]. They have a long history of drastic presence in human communities with extended geographical dispersion worldwide. For many years, they have been a significant public health issue and probably one of the most common ectoparasites in human life [3].

In 2010, the Centers for Disease Control and Prevention along with the U.S. Environmental Protection Agency identified bed bugs as a public health pest of concern, reflecting a consensus

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among public health officials regarding the significance of bed bugs as a public health issue. This recognition underscored the need for effective strategies to address the problem of bed bug infestations and protect people's well-being [4].

The surge in global travel, immigration, and the secondhand goods trade has led to the disruption of traditional bed bug geographical distributions, causing *C. lectularius* and *C. hemipterus* to inhabit overlapping regions. This sympatric occurrence of the two species has contributed to various clinical and psychological health issues for affected individuals [1, 5]. In addition, they cause multiple economic problems affecting cultural and tourism industries (e.g., the economic impact of the resurgence was 100 million AUS dollars in Australia) [6] Nowadays, Bed bug infestations have expanded beyond homes and hotels, becoming widespread in private and public spaces such as senior living facilities, healthcare centers, and public transportation. This expansion poses challenges in managing and eradicating these pests [7, 8].

Despite the availability of alternative methods like temperature treatments, including steam and dry ice, the application of insecticides via spraying remains the most effective long-term solution for preventing re-infestation [9]. Therefore, there is an urgent need to develop pest management tools that are not only effective in suppressing bed bug populations, but that do not themselves have undue negative impacts on human health [10, 11]. Pyrethroids are commonly employed in managing bed bugs and various other indoor pests [12, 13]. Plants offer a promising alternative for eco-friendly insect pest control, as they contain bioactive compounds and pose less risk to non-target organisms. Their ease of biodegradability further supports the preference for natural products in pest management strategies [14].

To the best of our knowledge and understanding to date, several studies have been reported on the chemistry, toxicity, and epidemiology of antimicrobial, insecticidal activity of Dumb cane plant [15, 16]. Nevertheless, this is the first study was conducted to assess on the insecticidal activity of diffenbachia plant extract against bedbugs, which is one of the potential public health and medical hazards in this country. Therefore the objective of this study was evaluating the Efficacy of *Dieffenbachia picta* (Araceae) Leaves insecticidal activity against Bed Bugs in Arba Minch Town.

2. Material and Methods

2.1. Study Area, Design and Period

Laboratory based experimental study was conducted at Arba Minch University in Entomology Laboratory, from March-July 30 2023. This research was carried out at the Gamo zone Arba Minch town. As shown in Figure 1, Arba Minch is both the Gamo Zone's administrative centre and the regional zone known at the Southern Ethiopia (SE). The town is located between 37 º28' 0" to 37 º36' 0" to the east and 5 º59' 0" to 6 º5'0" to the north., spanning a surface area of 2184 hectares. It is 504 kilometres from the capital city Addis Ababa. Its surface area is 2184 hectares, with an average temperature of 30.6 ℃ and an annual rainfall of 575 mm [17, 18].

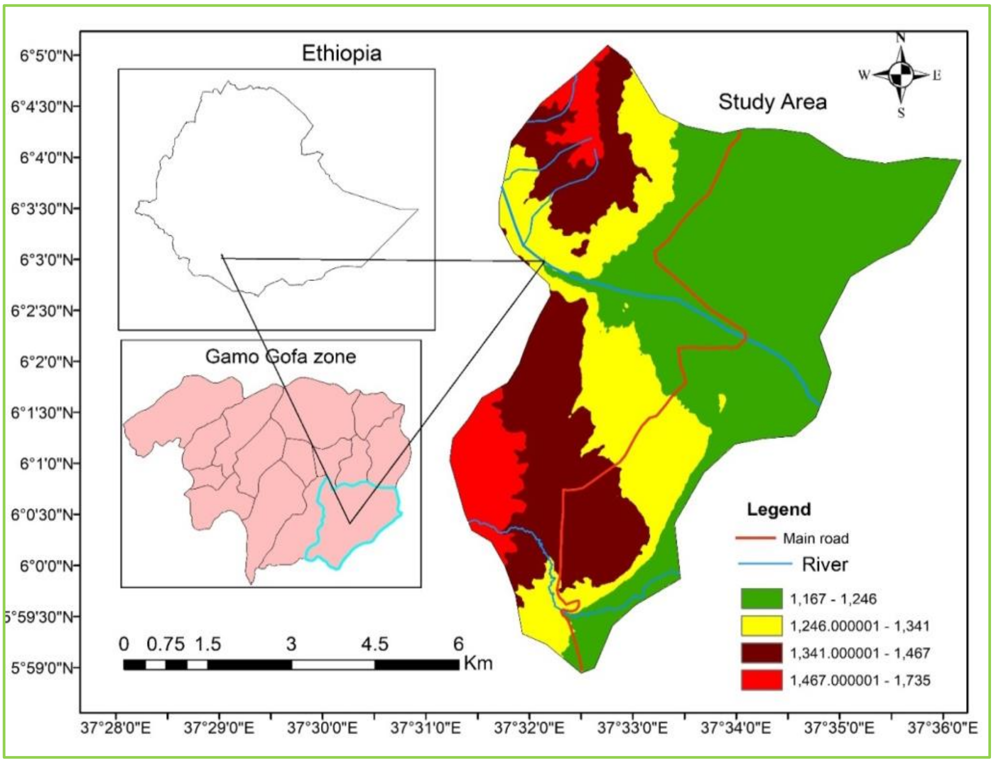


Figure 1. *Location Map of Arba Minch Town.*

2.2. Laboratory Procedure

2.2.1. Sample Collection

According to standard protocol, bedbugs were collected from multiple infested houses (apartments, homes, institutions) located in Arba Minch town, Gamo zone. This study maintained the insects in 240-ml glass rearing jars with 90-mm filter paper circles (Whatman no.1) and cardboard harborages folded in a fan-like shape. The rearing jar mouth was covered with nylon mesh with 90 µm openings to prevent insects from escaping [19]. A artificial feeding technique was used once a week to feed to engorgement [20]. Similarly, the plant materials were taxonomically identified and authenticated by Botanist in March 3, 20023 then, plant samples were aseptically collected by using sterilized containers from different from different area of Arba Minch town.

2.2.2. Plant Extract Preparation

Dumb cane (*Dieffenbachia picta*) plants were collected from Arba Minch town and district at different growing stages. The sample leaves were dried in shade at room temperature and then ground to a fine powder using an electric meal grinder [IKA.A11 BASIC, D-79219 Staufen].

2.2.3. Qualitative Determination of Phytochemical Constituents

According to Yadav and his collegue the extract was tested for the presence of bioactive compounds by using following standard methods [21]:

(i). Test for Phenols and Tannins

Crude extract was mixed with 2ml of 2% solution of FeCl3. A blue-green or black coloration indicated the presence of phenols and tannins.

(ii). Test for Steroid

In this test, the crude extract was combined with 2 ml of chloroform, followed by the careful addition of concentrated H_2SO_4 along the side of the container. The presence of steroids was indicated by the appearance of a red color in the lower chloroform layer. To further confirm the presence of steroids, another test was performed by mixing the crude extract with 2 ml of chloroform, followed by the addition of 2 ml each of concentrated H_2SO_4 and acetic acid. The observation of a greenish coloration in the resulting mixture provided additional evidence for the presence of steroids in the sample. Both colorimetric tests served as qualitative indicators for identifying steroidal compounds in the crude extract.

(iii). Test for Flavonoids

The plant extract was treated with 2-3 drops of sodium hydroxide solution. Acute yellow colour was formed, that indicates presence of the flavonoids, by the addition of some drops of sulphuric acid that changed to colourless.

(iv). Test for Saponins

Crude extract was mixed with 5ml of distilled water in a test tube and it was shaken vigorously. The formation of stable foam was taken as an indication for the presence of saponins.

(v). Test for Alkaloids

To test for the presence of alkaloids, the crude extract was combined with 2 ml of 1% HCl and heated gently. Subsequently, both Mayer's and Wagner's reagents were added to the mixture. The formation of a turbid precipitate was interpreted as an indication of the presence of alkaloids in the extract. This qualitative test provided preliminary evidence for the existence of alkaloid compounds within the crude extract.

(vi). Benedict’s Test

Crude extract when mixed with 2ml of Benedict’s reagent and boiled, a reddish brown precipitate formed which indicated the presence of the carbohydrates.

2.2.4. Insecticidal Activity by Topical Assay

Insecticidal studies using extracts from the dumb cane plant were conducted following the procedure described by Romero et al. [22]. In this study, adult bed bugs were meticulously separated using forceps and subsequently placed in Petri dishes. To immobilize the bed bugs, carbon dioxide (CO_2) was used as an anesthetic agent. For the treatment group, a solution containing varying concentrations (1 g/l to 0.053 g/l) of the plant extract, obtained through acetone, methanol, ethanol, or distilled water extraction, was carefully applied onto the dorsal abdomen of the insects using a 100 µl micropipette. Conversely, the control group received an application of 100 µl of acetone, distilled water, ethanol, or methanol alone. Following treatment, the bed bugs were transferred to 20 ml clear glass vials containing paper strips made from standard 92 multipurpose papers. These vials were then placed in a growth chamber to monitor the effects of the treatment. The mortality rates of the bed bugs were documented at 1, 2, 3, 5, and 7 days post-treatment to evaluate the efficacy of the plant extract in controlling bed bug populations. A bed bug was considered dead if no body part moved when touched with a needle. Each replicate consisted of 10 bed bugs (mixed sex), and there were 3 replicates in total.

2.2.5. Experimental Design for the Synergistic Effect

Mixture experimental design is the most suitable approach for predicting the response of a mixture and optimizing its composition to achieve maximum efficacy in terms of mortality rate, as the components of the mixture must always sum up to 100%. It is crucial to note that a mixture experiment is a particular type of response surface experiment, where the factors are the mixture's components, and the response is influenced by the relative proportions of each constituent [23, 24].

2.2.6. Factors

***Table 1.** Components of a mixture high and low value in the mixture design.*

Component	Name	Level	Low Level	High Level	Std. Dev.	Coding
A	methanol	10.58	10.00	30.00	0.0000	Actual
B	ethanol	21.06	20.00	40.00	0.0000	Actual
C	acetone	48.32	30.00	50.00	0.0000	Actual
D	distill water	20.04	20.00	40.00	0.0000	Actual
	Total =	100.00				

Here is the canonical form of a third-order polynomial model:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_{11} x_1^2 + \beta 22 x_2^2 + \beta_{33} x_3^2 + \beta_{44} x_4^2 + \beta_{12} x_1 x_2 + \beta_{13} x_1 x_3 + \beta_{14} x_1 x_4 + \beta_{23} x_2 x_3 + \beta_{24} x_2 x_4 + \beta_{34} x_3 x_4 + \varepsilon \quad (1)$$

In this model: Y represents the response variable, β0 is the intercept term, β1 to β4 are the linear regression coefficients for each component, X1 to X4, respectively, β11 to β44 are the quadratic regression coefficients for the squared terms of each component (x_1^2 to x_4^2), β_{12} to β_{34} are the interaction regression coefficients for the pairwise interactions between components (x_1x_2, x_1x_3, x_1x_4, x2x3, x2x4, and x3x4), x1 to x4 represent the proportions of the four components in the mixture, ε is the error term, representing the deviation between the observed and predicted response values. The design expert software was used to generate 20 formulations for developing predictive models and determining the optimum synergistic effect.

2.3. Data Analysis

All experiments were performed in triplicates. In case of Lattice mixture design (LMD) analysis all experimental data were checked and coded for its completeness by Microsoft Excel 2010 and exported to Design Expert 11 software. Data were analyzed by one-way ANOVA, and a P-value of ≤ 0.05 was considered as the statistical significance level.

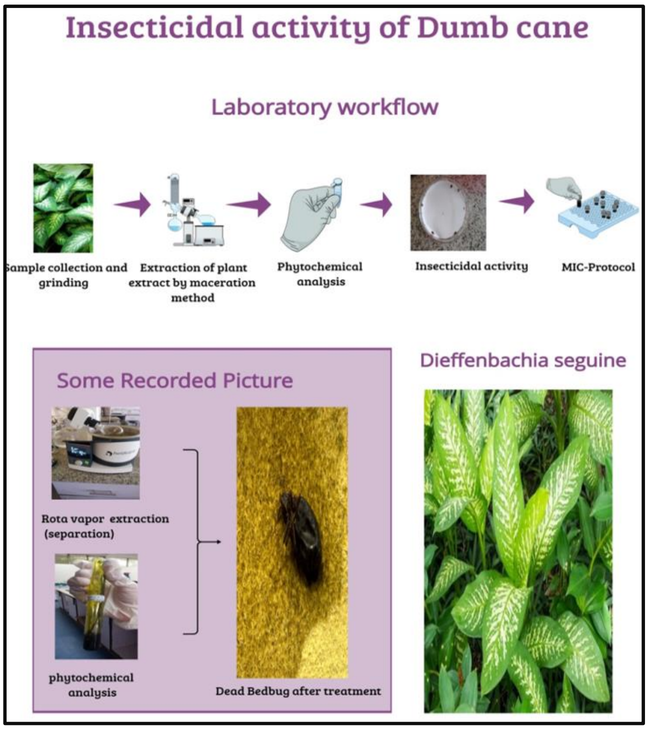


***Figure 2.** Infographics representation of this study.*

3. Results and Discussion

3.1. Phytochemical Analysis

Table 2 illustrates the results of the qualitative phytochemical analysis conducted on extracts of *Dieffenbachia picta* using methanol, ethanol, distilled water, and acetone. As indicated in the table, the leaf extract of this plant contained saponins, flavonoids, phenols, alkaloids, and reducing sugars. However, no tannins or steroids were detected. The qualitative analysis revealed potential therapeutic applications, suggesting the presence of known pharmacological properties [25, 26]. A similar finding was demonstrated in a study conducted at the University of Ibadan, Nigeria. The study found that the extracts of leaves contained alkaloids, saponins, phenol, and resins [16].

Table 2. *Phytochemical analysis of Dieffenbachia plant extract.*

Phytochemical compounds	Leaf extract
Tannins	-
Saponins	+
Steroids	_
Flavonoids	+
Phenols	+
Alkaloids	+
Reducing sugar	+

Where, + = Present, - =Beyond detectable limit

3.2. Efficacy of Dumb Cane Plant on the Mortality of Bedbug

Figure 3 illustrates the effectiveness of dumb cane plant extract in combating bedbugs. The extract was obtained through the maceration method using various solvent extracts. The concentration of the plant extracts ranges from 1 g/l to 0.053 g/l. In Figure 3a, the methanol extract of dumb cane plant demonstrates its efficacy against bedbugs. The figure shows that a concentration of 1 g/l results in a 100% mortality rate. The concentrations of 0.375 g/l, 0.14 g/l, and 0.053 g/l exhibit mortality rates of 90%, 80%, and 70% respectively. Similarly, the ethanol extract of dumb cane plant also shows similar efficacy. As shown in Figure 3b, concentrations of 1 g/l, 0.375 g/l, 0.14 g/l, and 0.053 g/l exhibit mortality rates of 80%, 80%, 70%, and 60% respectively. Figure 3c also demonstrates the effectiveness of dumb cane plant extract with mortality rates of 80%, 70%, 60%, and 50% for concentrations of 1 g/l, 0.375 g/l, 0.14 g/l, and 0.053 g/l respectively. Similarly, Figure 3d shows mortality rates of 70%, 60%, 40%, and 30% for concentrations of 1 g/l, 0.375 g/l, 0.14 g/l, and 0.053 g/l respectively. The findings in Figure 3 align with previous studies highlighting the potential of plant-based extracts as eco-friendly alternatives for pest control [27].

Our study demonstrated that dumb cane plant extracts obtained using various solvents (methanol, ethanol, distilled water, and acetone) exhibited significant insecticidal activity against bedbugs. While there is limited information on the insecticidal activity of dumb cane plant extracts against bedbugs, our findings align with previous studies that have reported the potential of plant-derived extracts as effective alternatives to conventional pesticides [28]. The current study expands the knowledge on natural pest control agents, with a specific focus on bedbugs, which are a significant public health concern [29]. Moreover, The study done in Nigeria also provides valuable insights into the biological activities and potential therapeutic applications of dumb cane plant extracts [16].

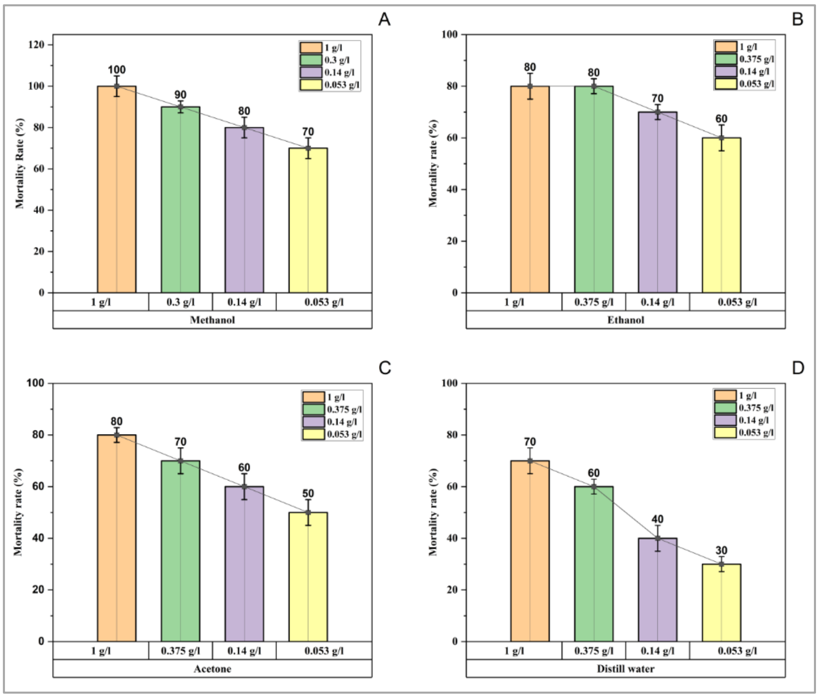


Figure 3. *Efficacy of Dumb Cane Plant Extract against Bedbugs using Various Solvent Extracts.*

Figure 4. *Mortality Effects of Dumb Cane Plant Extract on Bedbugs at Various Concentrations.*

3.3. Lattice Mixture Design for the Synergistic Effect of Different Dumb Cane Plant Extract

Using mortality rate as the output response, lattice mixture design was used to determine the optimum synergistic effects for the four significant variables (methanol, ethanol, Acetone and distill water). Our study consists of 20 experiments that combine the four selected variables in different ways. In Table 3, we present the experimental designs that were used.

Table 3. *Mixture design, experimental conditions and measured responses.*

Run	A: Methanol	B: Ethanol	C: Distill water	D: Acetone	Response (Mortality rate %)		Residual
					Actual	predicted	
1	17.5	30	27.5	25	90	89.83	0.1679
2	25	30	20	25	100	99.96	0.0420
3	13.75	33.75	23.75	28.75	90	88.66	1.34

Run	A: Methanol	B: Ethanol	C: Distill water	D: Acetone	Response (Mortality rate %)		Residual
					Actual	predicted	
4	19.375	31.875	21.875	26.875	95	95.67	-0.6716
5	10	45	20	25	85	84.96	0.0420
6	17.5	37.5	20	25	90	89.92	0.0840
7	17.5	30	20	32.5	90	89.83	0.1679
8	10	30	20	40	85	84.96	0.0420
9	11.875	31.875	29.375	26.875	85	85.67	-0.6716
10	10	45	20	25	85	84.96	0.0420
11	17.5	37.5	20	25	90	89.92	0.0840
12	25	30	20	25	100	99.96	0.0420
13	10	37.5	27.5	25	85	84.83	0.1679
14	10	30	27.5	32.5	85	84.83	0.1679
15	11.875	39.375	21.875	26.875	85	85.67	-0.6716
16	11.875	31.875	21.875	34.375	85	85.67	-0.6716
17	10	37.5	20	32.5	85	84.83	0.1679
18	10	30	20	40	85	84.96	0.0420
19	10	30	35	25	85	84.96	0.0420
20	10	30	35	25	85	84.96	0.0420

Among the total of 20 experiments conducted to test the mortality rate of bedbugs using a combination of four extracts, experiment 12 showed the highest mortality rate of 100%. This impressive result was achieved by combining 25% methanol, 30% ethanol, 25% acetone, and 20% distilled water. Therefore, this particular combination effectively demonstrated the optimal synergistic effect of the extracts against bedbug spp.

3.4. Model Developed for the Synergistic Effect in Terms of L-Pseudo Components

The equation below represents the relationship between the dependent variables (response) and the independent variables (parameters):

$$Y\ (\text{Mortality rate}) = +99.96A++84.96B++84.96C+84.96D-10.17AB-10.50AC-10.50AD-0.5037BC-0.5037BD-0.5037CD+150.52ABC+150.52ABD+153.21ACD-326.79BCD \quad (2)$$

The equation in terms of coded factors can be used to make predictions about the response for given levels of each factor. By default, the high levels of the mixture components are coded as +1 and the low levels are coded as 0. The coded equation is useful for identifying the relative impact of the factors by comparing the factor coefficients.

3.5. ANOVA for Special Cubic Model

Table 4. *ANOVA results for response parameters.*

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	459.97	13	35.38	56.19	< 0.0001	significant
(1)Linear Mixture	436.77	3	145.59	231.22	< 0.0001	

Source	Sum of Squares	df	Mean Square	F-value	p-value
AB	8.62	1	8.62	13.69	0.0101
AC	5.54	1	5.54	8.79	0.0251
AD	5.54	1	5.54	8.79	0.0251
BC	0.0127	1	0.0127	0.0202	0.8916
BD	0.0127	1	0.0127	0.0202	0.8916
CD	0.0127	1	0.0127	0.0202	0.8916
ABC	1.59	1	1.59	2.52	0.1634
ABD	1.59	1	1.59	2.52	0.1634
ACD	1.63	1	1.63	2.58	0.1590
BCD	7.41	1	7.41	11.76	0.0140
Residual	3.78	6	0.6297		
Lack of Fit	3.78	1	3.78		0.6915
Pure Error	0.0000	5	0.0000		
Cor Total	463.75	19			

(1) Inference for linear mixtures uses Type I sums of squares.

Mixture Component coding is L_Pseudo.

Sum of squares is Type III - Partial

The Model F-value of 56.19 signifies the model's significance, as there is only a 0.01% probability that such a large F-value could result from random noise. P-values lower than 0.0500 denote significant model terms, with A, B, C, D, AB, AC, AD, and BCD being significant in this case. Values exceeding 0.1000 imply insignificant model terms. If numerous insignificant terms are present (excluding those necessary for hierarchy support), model reduction may enhance the model's overall quality.

Table 5. *Fit Statistics for response parameters.*

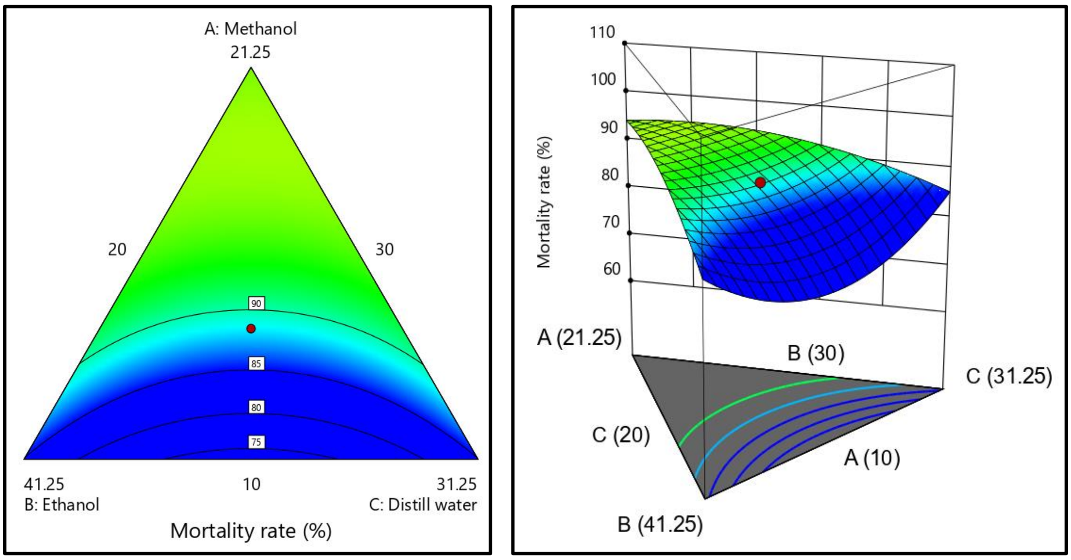
Std. Dev.	0.7935	R^2	0.9919
Mean	88.25	Adjusted R^2	0.9742
C.V. %	0.8992	Predicted R^2	-4.7484
		Adeq Precision	22.7834

A negative Predicted R^2 implies that the overall mean may be a better predictor of your response than the current model. In some cases, a higher order model may also predict better. Adeq Precision measures the signal to noise ratio. A ratio greater than 4 is desirable. Your ratio of 22.783 indicates an adequate signal. This model can be used to navigate the design space.

3.6. Synergistic Effect of Different Solvent Extract

3.6.1. Synergistic Effect of Methanol, Ethanol and Distill Water

Figure 5a and b illustrate a ternary mixture design containing three components: methanol (A), ethanol (B), and acetone (C). The response graph, shown as a contour plot, displays the insecticidal activity (mortality rate) of various mixtures on bed bugs. Different mortality rates are indicated by colors: red (highest, 100%), green (intermediate, 90%), and blue (lowest, 70-85%).



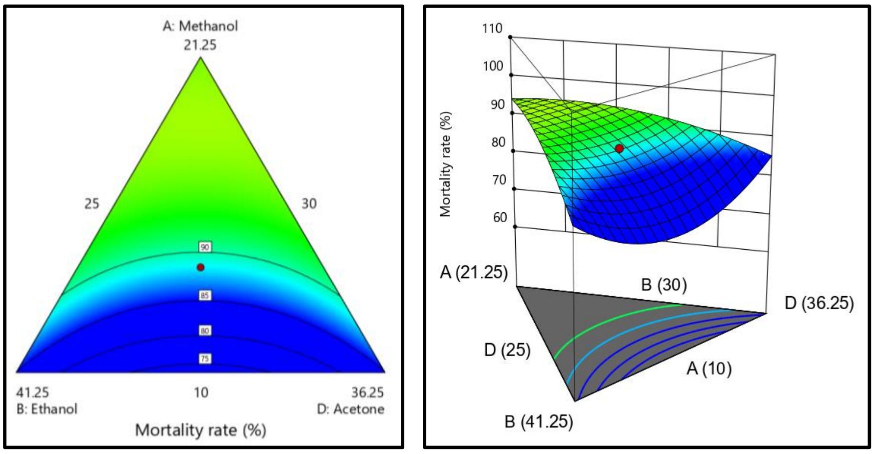
A B

Figure 5. Ternary diagrams of methanol, ethanol and distill water mixture composition.

The green region between vertices A and B represents moderate mortality, while the yellowish color at the end of vertex A suggests that as the concentration of component A (top vertex) increases, the mortality rate improves and becomes higher. Between vertices B and C, the blue region indicates the lowest mortality rate. The light blue color in the middle of the ternary design suggests that as the concentration of components B and C increases, the mortality rate slightly improves but remains low. On the other hand, between vertices A and C, the green region suggests moderate mortality, and the yellow color near vertex A indicates an improvement in the mortality rate as the concentration of component A increases. The contour lines within the design depict a region of 90% mortality near the center, with vertices A (Methanol) at 13.75%, vertices B (ethanol) at 33.75%, vertices C (distilled water) at 23.75%, and the actual component of acetone at 28.75%. Equation 2 demonstrates that the combined effect of +150.52ABC is characterized by a positive quadratic coefficient, indicating that an increase in these three variables, especially the methanol extract, leads to an increase in the response value of the bedbug mortality rate.

3.6.2. Synergistic Effect of Methanol, Ethanol and Acetone

The contour lines within the design reveal a 90% mortality region near the center with 13.75% methanol, 33.75% ethanol, 28.75% acetone, and 23.75% distilled water. The blue area between vertices B and C indicates the lowest mortality rate. Equation 2 shows a positive quadratic coefficient of +150.52ABD, demonstrating that increasing these three variables, particularly methanol extract, results in higher bed bug mortality rates.

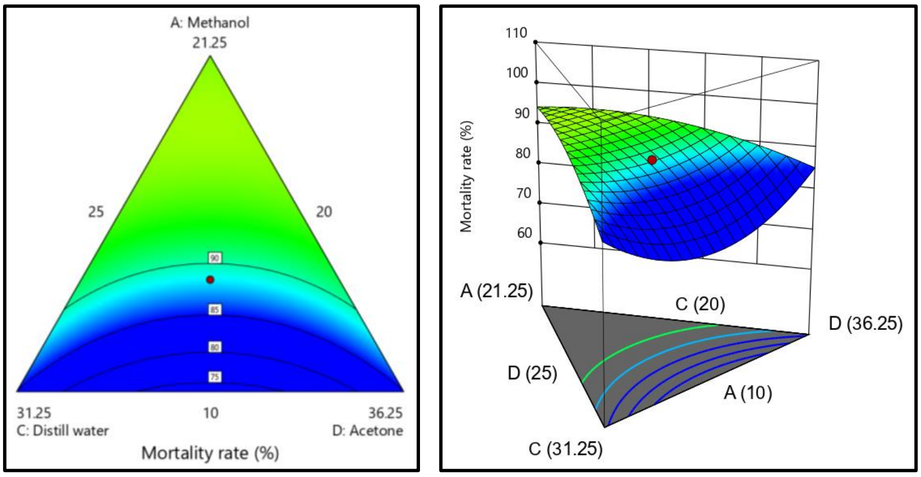


A B

Figure 6. Ternary diagrams of methanol, ethanol and acetone mixture composition.

3.6.3. Synergistic Effect of Methanol, Acetone and Distill Water

Likewise, similar to the previous synergistic effect, methanol also has a significant impact on the mortality rates of bedbugs. As shown in the ternary graph, particularly on the contour line, the mortality rate improves as the values of component A, C, and D improve. However, the most significant improvement in mortality rate is observed when component A improves, as depicted in figure 7. This conclusion is further supported by the +153.21ACD coefficient of the combined variable in Equation 3. The light blue color in the middle of the ternary graph suggests that although the mortality rate slightly improves, it remains low as the concentration of component D and C increases.

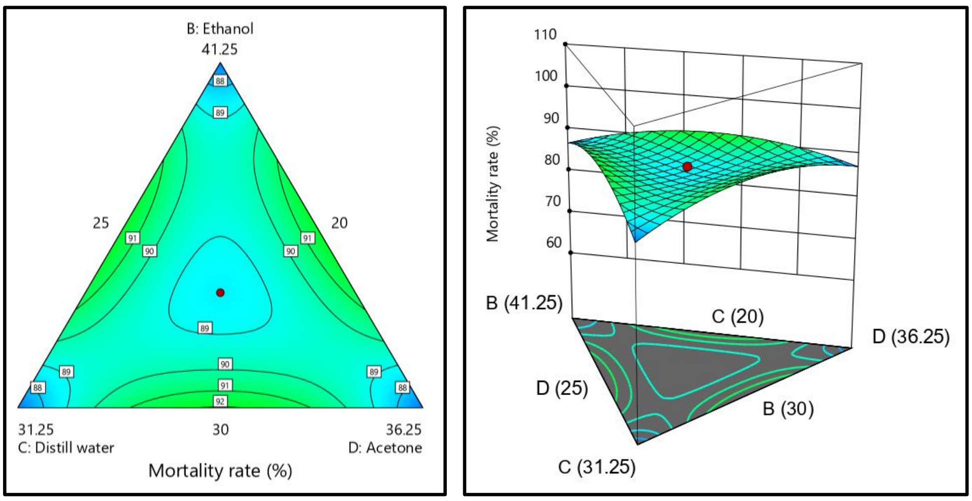


A B

Figure 7. Ternary diagrams of methanol, distill water and acetone mixture composition.

3.6.4. Synergistic Effect of Acetone, Ethanol and Distill Water

The synergistic effect of acetone, ethanol, and distilled water on bed bug mortality rate is evident. The figure shows that increasing these three components initially enhances the mortality rate; however, further increases do not necessarily lead to higher mortality rates, as seen in the contour lines. The green color along the lines between vertices C and B, B and D, and C and D suggests moderate mortality rates. This observation is further supported by the negative quadratic coefficient of -326.79BCD in Equation 3, indicating that excessive amounts of these combined variables may not improve bed bug mortality rates.



A B

Figure 8. Ternary diagrams of ethanol, distill water and acetone mixture composition.

3.6.5. Synergistic Effect Using Desirability Function

The ramp functions graph (Figure 9) shows the desirability for synergistic effect. The dot on each ramp indicates the factor setting (or) response prediction for that response characteristic. According to the findings from the desirability ramp depicted in Figure 9, each point on the ramp signifies either a factor setting or a predicted response. Consequently, the best mix of composition parameters was identified at a methanol extract concentration of 10.1561%, ethanol extract concentration of 30.4123%, and acetone extract concentration of 30.7722%, and distill water extract concentration of 28.6595% with an anticipated optimal synergistic effect (mortality rate) at 83.2811% and an overall desirability score of 1.000 (Figure 9).

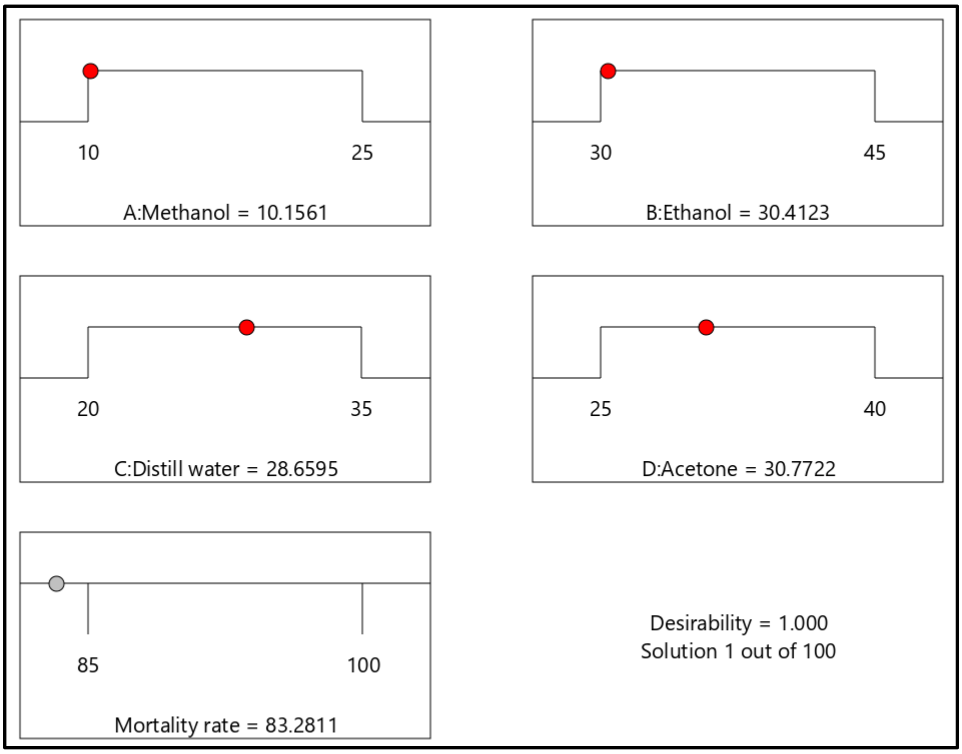


Figure 9. *Desirability ramp of the synergistic effect of different solvent extract.*

The purpose of optimization using the desirability function is to find a combination of conditions that concurrently fulfill all goals. The desirability scale for each response ranges from 0 to 1 with 1 being the ideal solution (more desirable) and 0 indicating that one or more responses fall outside the desired range (least desirable) [30]. In this context, the response becomes more satisfying as the desirability value increases [31]. Based on the graph in Figure 9, the composite desirability of mortality rate is 83.2811% indicating a better response.

4. Conclusion

In conclusion, this study demonstrates that extracts from Dieffenbachia picta have the potential to serve as a natural solution for controlling bedbugs. The qualitative phytochemical analysis reveals the presence of saponins, flavonoids, phenols, alkaloids, and reducing sugars in the leaf extracts, which suggests possible therapeutic applications. Moreover, the study establishes the effectiveness of these extracts as an alternative method for pest control by subjecting bedbugs to different concentrations of dumb cane plant extracts obtained through the maceration method using various solvents. The lattice mixture design indicates that the highest mortality rate of 100% is achieved when using a combination of 25% methanol, 30% ethanol, 25% acetone, and 20% distilled water extract. These results underscore the importance of exploring plant-based alternatives and their synergistic effects in combating the global problem of bedbug infestations. Overall, this study provides valuable insights into the potential of Dieffenbachia picta extracts as an eco-friendly and efficient solution for managing bedbug populations.

Abbreviations

ANOVA	Analysis of Variance
LMD	Lattice Mixture Design
SE	Southern Ethiopia

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Author Contributions

Fitsum Dejene is the sole author. The author read and approved the final manuscript.

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Data Availability Statement

No datasets were generated or analyzed during the current study.

Conflicts of Interest

The author declares no conflicts of interest.

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