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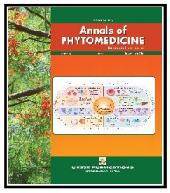

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Harnessing of Jatropha oil-based formulation for the management of white grub (*Lepidiota mansueta* Burmeister) and termite (*Odontotermes obesus* Rambur)

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Abstract

The present study was conducted at the Chemical Ecology Laboratory, Department of Entomology, Assam Agricultural University (AAU), Jorhat, during 2021-22 to evaluate Jatropha oil-based formulations against white grub, *Lepidiota mansueta* Burmeister, and termite, *Odontotermes obesus* Rambur. Jatropha oil-based formulation was tested on targeted insects, individually and in combinations of the adjuvants. In *L. mansueta*, the highest per cent mortality was observed in 7% concentration after 48 h. At 48, 72, 96, and 120 h of exposure, the LC_{50} values were determined to be 25.30, 18.59, 2.85, and 1.16%, respectively. The 1% concentration of the tested formulation resulted in the highest LT_{50} value, 112.21 h, while the lowest was 68.72 h. In the *O. obesus* experiment, the maximum mortalities were 30, 40, 52, 68, 86, and 94% after 6, 9, 12, 24, 48, and 72 h at 7%. The Jatropha oil-based formulation's LC_{50} values were 30.42, 25.72, 16.60, 5.09, 1.04, and 0.81% at 6, 9, 12, 24, 48, and 72 h. The lowest recorded LT_{50} value was 15.02 h, while the highest, 43.19 h, was achieved at 1% concentration. The GC-MS analysis identified 172 compounds with strong insecticidal properties across the three botanical inputs (Jatropha oil, aloe vera, and soapberry) in the formulation, like linoleic acid, triterpenoid saponins, and D-limonene.

1. Introduction

The term "soil insects" refers to any insect that spends its developing or foraging stages on or below the soil surface. They can be microscopic or several inches long, and cause at least some harm to farmed fields in the world. Based on their roles in soil, arthropods can be classified as shredders, predators, vegetarians, and fungal feeders. Diversity of insect herbivores, particularly species of Coleoptera, Orthoptera, Diptera, Homoptera, Lepidoptera, and Hymenoptera, all go through a phase of their life cycles where they feed on roots. The white grub (Coleoptera: Scarabaeidae) and termites (Isoptera: Termitidae) are among the most destructive soil insects, causing serious yield loss in cereals, sugarcane, tea, and several other field and plantation crops across India (Brown and Gange, 1990; Oloo, 1990; Ranger *et al*., 2009; Chandel *et al*., 2013). Their cryptic nature often leads to repeated application of synthetic insecticides, leading to hazards like non-target toxicity, environmental contamination, residual persistence, and gradual development of insect resistance (Pujari *et al*., 2017).

L. mansueta, a biennial scarab species with an extended larval stage, has occurred as a major root-feeding pest in Assam and parts of Northeastern India with severe crop damage. As previously indicated, it severely harms a range of crops on Majuli Island, necessitating the immediate control measures. White grubs spend most of their lifespan underground, and therefore, they are usually difficult to control (Choudhury, 1999; Bhattacharyya *et al*., 2015). Likewise, *O. obesus* is recognised as one of the most destructive mound-building termites, inflicting significant losses in sugarcane, tea, and other economically important crops (Choudhury, 1999; Pardeshi *et al*., 2010; Bhagawati *et al*., 2017).

The strategy of exclusive reliance on synthetic insecticides has created several ecological and environmental problems in addition to aggravating pest attacks on crops. An increase in the cost of pesticides has further established the need for evolving biodegradable, economic, and socially acceptable products of pest management with greater selectivity. For these reasons, the utilisation of botanical pesticides in Integrated Pest Management (IPM) becomes a priority. Plant oils are good contact insecticides (Rahman *et al*., 2006). It acts as repellent and may impact growth, life span, and reproduction (Sauerwein *et al*., 1993). Plant oils' toxicant, fumigant, repellent, antifeedant, and insect growth regulator properties make them promising botanicals for pest control (Chaieb, 2010).

Jatropha curcas L. (Euphorbiaceae) is a well-documented phytochemical reservoir, known to contain a wide array of bioactive constituents including unsaturated fatty acids (oleic and linoleic acids), diterpenoid phorbol esters, terpenes, flavonoids, sterol, and phenolic

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compounds (Sauerwein *et al*.,1993; Solsoloy, 1995; Abelgadir *et al*., 2013). Several of these constituents have been individually associated with insecticidal activity. Unsaturated fatty acids are reported to disrupt insect cell membranes and interfere with respiratory and neuromuscular functions (Sutthanont *et al*., 2010; Azevedo *et al*., 2021), while monoterpenes such as limonene exert neurotoxic and repellent effects through modulation of insect monoterpene neotransmission (Tapondjou *et al*., 2002). Phorbol esters, the signature toxic compounds, act at the molecular level by mimicking diacylglycerol and persistently activating protein kinase C, leading to disruption of cellular signalling, impaired metabolism, and insect mortality (Sauerwein *et al*., 1993; Verma *et al*., 2001; Abelgadir *et al*., 2013). In addition, saponins and related triterpenoids present in botanical formulations are known to compromise insect gut integrity by complexing with sterols present in the membrane, inhibiting growth and causing death (Chaieb, 2010).

Despite many reports demonstrating the pesticidal potential of *J. curcas* extracts and oils, most studies have focused primarily on formulation-level bioassay with limited emphasis on phytochemical profiling and mechanism-based interpretation of bioactivity. Due to the vast spectrum of biological features of Jatropha seed oil, a fresh attempt was undertaken to develop a Jatropha oil-based formulation to determine the dose needed to kill 50% of the test insects, with particular emphasis on gas chromatography-mass spectrometry (GC-MS) based phytochemical characterisation and mechanism driven interpretation of insecticidal activity.

2. Materials and Methods

2.1 Collection of target insects and their rearing under laboratory conditions

L. mansueta (Figure 1), third instar grubs were obtained from the riverside of Maharichuk Village on Majuli Island in July-August 2022 as test insects. Due to their high rate of cannibalism, characteristics grubs were kept individually in each disposable plastic glass and brought to the laboratory. Larvae were raised in disposable plastic glass (8 cm height x 5 cm diameter) in the lab. The 3/4th portion of each glass was filled with sterilized Majuli soils (autoclaved at 120°C), and cut potato was offered as feeding material to the reared grubs. Glasses were covered with a black muslin cloth. The soil inside the glass was kept moistened by spraying water. *O. obesus* worker termites (Figure 2) were gathered from the Experimental Garden of Plantation Crops, Department of Tea Husbandry and Technology. The termites were removed from the active termite mounds whenever required. Due to the presence of termites within the AAU campus, they were not raised in the laboratory setting but rather were freshly gathered for the experiment. Before starting the experiment, the worker termites were examined using a soft camel hair brush under a stereo zoom microscope, and only the uniform-sized healthy workers were selected.

Figure 1: Third instar grub (*L. mansueta*).

Figure 2: Worker termite (*O. obesus*).

Figure 3: Jatropha oil-based formulation.

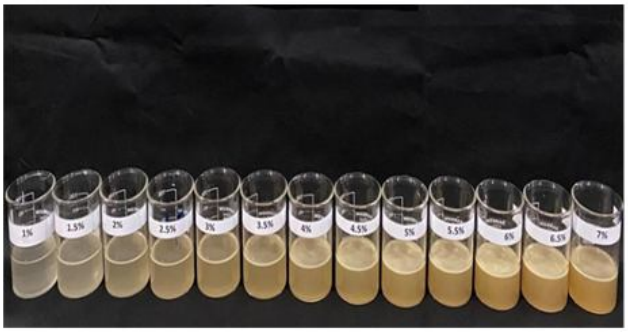

Figure 4: Preparation of per cent solution of Jatropha oil-based formulation.

2.2 Collection and preparation of Jatropha oil-based formulation

The biopesticide, Jatropha oil-based formulation (Figure 3), was prepared as a mixture of Jatropha oil, ethyl alcohol, soapberry, and aloe vera with a ratio of 50:30:10:10, and the insecticide clothianidin 50 WDG (Water Dispersible Granules) was used as a check in the Chemical Ecology Laboratory, AAU, Jorhat. Serial dilution was used to prepare biopesticide doses from the stock solution (Figure 4). Treatments with merely the adjuvants (except Jatropha oil) were also tested on test insects separately and in varied combinations.

2.3 Bioassay study

The soil dip method against *L. mansueta* was carried out in plastic glasses (8 cm height × 5 cm diameter) containing sterile soil (50 g) from Majuli and cut potatoes were used as food source. The soil was sterilized in an autoclave by maintaining 120°C temperature and 15 lbs of pressure. The healthy and active third instar larvae were released into the treated soil. Ten plastic glasses containing one grub each were considered as one treatment. Each treatment had five replications. The mortality has been observed after 48, 72, 96, and 120 h (Figure 5). The residual film method against *O. obesus* was carried out by preparing different concentrations of the formulation and the insecticide clothianidin 50 WDG as a check. The treatments were applied as a thin film to the cellulose filter paper (4.5 cm diameter), which was placed on the petri plate (5 cm diameter). At room temperature, the solvent from the treated filter paper was air-dried. Each treatment had five replications with ten worker termites per petri plate. For filter paper control, distilled water was used. Further, petri plates with covers were left undisturbed to record the mortality after 6, 9, 12, 24, 48, and 72 h (Figure 6).

For the determination of LC_{50} and LT_{50} values, the Jatropha oil-based formulation was considered as the standard (100%). The serial dilution process using distilled water was used to create subsequent concentrations. The number of deaths in each treatment was calculated, and mortality was documented in control. Abbott's formula (1925) was used to rectify treatment mortality data (Abbott, 1925). The experiment has been repeated when the mortality in control exceeded 20%.

Corrected mortality =

$$\frac{\%\text{ mortality in treatment} - \%\text{ mortality in control}}{100 - \%\text{ mortality in control}} \times 100$$

Finney (1971) described "Probit analysis" of experimental data. The median lethal concentration (LC_{50}) and median lethal time (LT_{50}) were calculated using SPSS probit analysis and the regression equation.

Figure 5: Experimental setup of *L. mansueta*.

Figure 6: Experimental setup of *O.obesus*.

2.4 Detection of volatile compounds through gas chromatography-mass spectrometry

GC-MS was performed on the Jatropha oil-based formulation. The volatile extract prepared by eluting n-hexane was injected directly into the GC-MS system. The instrument was a Thermo Fisher ISQ 7000/MININT-NH9G93A_1, the sample inlet temperature was 250°C, the chromatographic column was a TG-5MS (30 m × 0.25 mm × 0.25 µm). Helium (He) was the carrier gas, the flow rate was constant and the column flow rate was at 1 ml/min. The programmed temperature rise was 40°C (5 min), 10°C/min to 150°C, 25°C/min to 250°C and then it was kept for 5 min. The total run time was 59.49 min. Mass spectrometer (MS) was operated at ionizing energy of 70 eV (Electron volts) and the temperature of the ion source was at 250°C. The MS transfer line temperature was recorded at 250°C. And the peak identification was done at EI (Electron Ionization) mass spectral data comparison with NIST11.L Library. Peak areas were obtained using the total ion chromatogram and expressed as relative percentage peak area for semi-quantitative comparison of constituents. It is acknowledged that GC-MS provides tentative identification only, particularly for isomeric and thermolabile compounds.

3. Results

3.1 Effect of Jatropha oil-based formulation against *L. mansueta*

The highest mortality rates of *L. mansueta* were 42, 58, 72, and 88% after 48, 72, 96, and 120 h at 7% concentration. After 48, 72, 96, and 120 h, 6.5% concentration caused 35, 50, 68, and 84% mortality (Figure 7). The lowest mortality of *L. mansueta* was 14, 32, 50, and 62% at 1% AAU Jatropha oil-based formulation. Grub mortality increased gradually with concentration and exposure time. However, formulation adjuvants did not affect grub mortality. In this present investigation, clothianidin 50WDG was used as the check on *L. mansueta*. The comparison of relative toxicity revealed that the

highest concentration of the formulation resulted in relatively less toxicity than the standard check (clothianidin 50WDG), which registered 44, 72, and 100% mortality at 48, 72, and 96 h, respectively. The regression equations ranged from Y = -0.938 + 0.669X (48 h) to Y = -0.036 + 0.552X (120 h), with low standard errors (0.14-0.15) and chi-square values (0.63-6.92), confirming good model fit. The LC_{50} values of the Jatropha oil-based formulation against *L. mansueta* at 48, 72, 96, and 120 h exposure were 25.30, 18.59, 2.85, and 1.16% (Table 1).

3.2 Effect of Jatropha oil-based formulation against *O. obesus*

The highest mortality rates of *O. obesus* were 30, 40, 52, 68, 86, and 98% after 6, 9, 12, 24, 48, and 72 h at 7% concentration. It was followed by a 6.5% concentration with 28, 36, 48, 66, 82, and 92% mortality after 6, 9, 12, 24, 48, and 72 h, respectively, as shown in the graph (Figure 8). *O. obesus* had the lowest mortality at 1% Jatropha oil-based formulation (6, 16, 26, 36, 62, and 74%). The percentage of termites that died grew progressively with increasing concentration and exposure time. Moreover, formulation adjuvants did not affect *O. obesus* mortality. In the present investigation, clothianidin 50WDG was kept as the check on the worker termite. The comparison of relative toxicity revealed that the highest concentration of Jatropha oil-based formulation resulted in relatively less toxicity than the check (clothianidin 50WDG), which registered 36, 48, 58, 76, 94 and 100% at 6, 9, 12, 24, 48, and 72 h, respectively. The regression equations ranged from Y = -1.131 + 0.802X (6 h) to Y = -0.064 + 0.713X (72 h) with standard errors between 0.16 and 0.14. The chi-square values (1.12-16.09) indicated an acceptable fit between observed and expected mortality. Jatropha oil-based formulation LC_{50} values at 6, 9, 12, 24, 48, and 72 h exposure were 30.42, 25.72, 16.60, 5.09, 1.04, and 0.81%, respectively (Table 2).

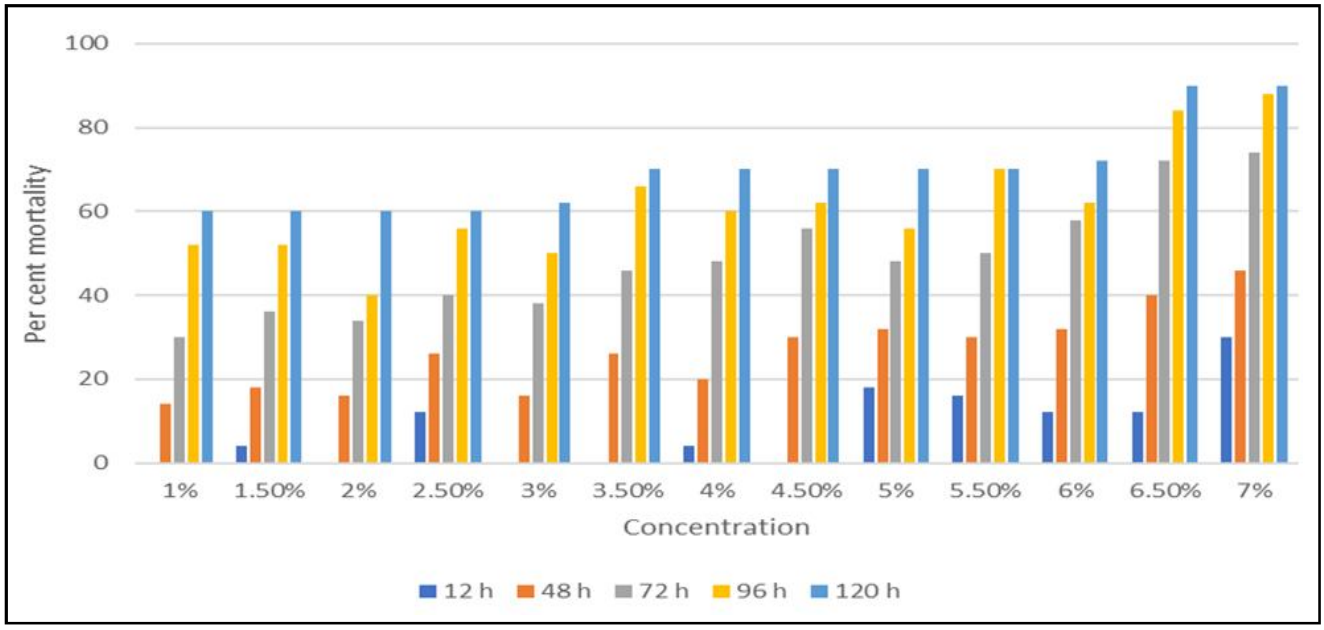

Figure 7: Mortality of *L. mansueta* caused by Jatropha oil-based formulation.

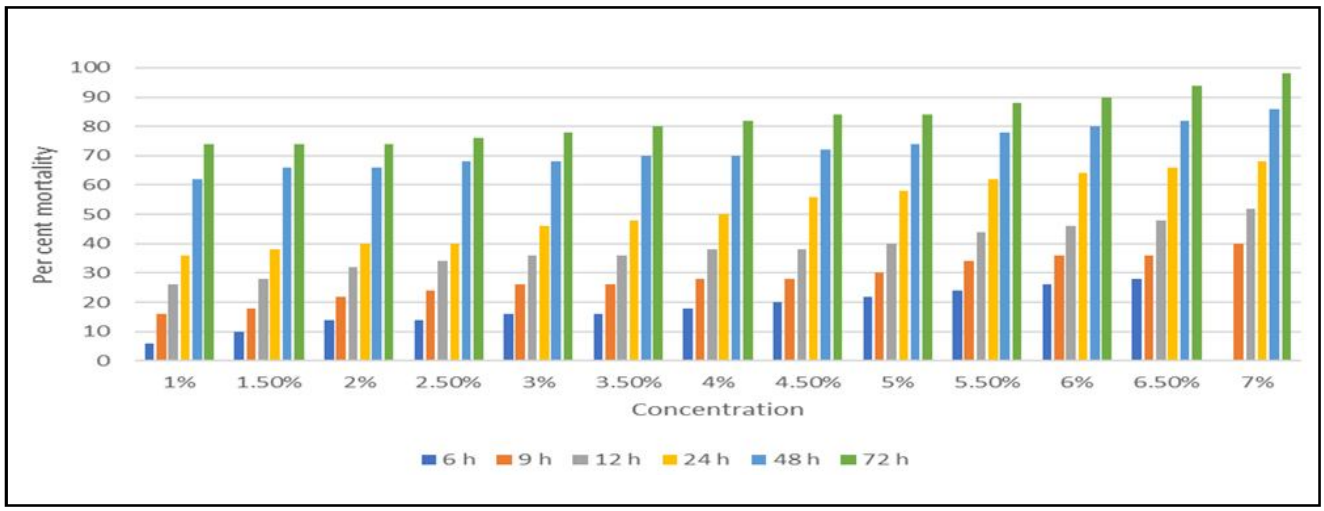

Figure 8: Mortality of *O. obesus* caused by Jatropha oil-based formulation.

Table 1: Median lethal concentration (LC_{50}) values of different concentrations of Jatropha oil-based formulation against *L. mansueta*

Treatment	Regression equation	Standard error of regression coefficient	Chi-square	LC_{50} (%)	Fiducial limit	
					Lower limit	Upper limit
48 h	Y = -0.938 + 0.669X	0.15	6.92	25.30	13.39	126.11
72 h	Y = -0.418 + 0.329X	0.14	1.90	18.59	7.98	103.60
96 h	Y = -0.169 + 0.371X	0.14	0.63	2.85	1.11	4.54
120 h	Y = -0.036 + 0.552X	0.141	1.91	1.16	0.37	1.79

Y = Probit kill, X = log concentration, Five replications with ten individuals each determine mortality.

Table 2: Median lethal concentration (LC_{50}) values of different concentrations of Jatropha oil-based formulation against *O. obesus*

Treatment	Regression equation	Standard error of regression coefficient	Chi-square	LC_{50} (%)	Fiducial limit	
					Lower limit	Upper limit
6 h	Y = -1.131 + 0.802X	0.16	1.12	30.42	13.41	540.44
9 h	Y = -0.758 + 0.511X	0.15	0.56	25.72	4.42	93.77
12 h	Y = -0.547 + 0.449X	0.14	0.85	16.60	8.57	237.97
24 h	Y = -0.435 + 0.615X	0.14	2.10	5.09	3.92	7.99
48 h	Y = -0.007 + 0.420X	0.14	2.56	1.04	0.09	1.82
72 h	Y = -0.064 + 0.713X	0.14	16.09	0.81	0.31	1.27

Y = Probit kill, X = log concentration, Five replications with ten individuals each determine mortality.

3.3 Qualitative and semi-qualitative GC-MS profiling of Jatropha oil-based formulation

The GC-MS analysis identified several phytochemicals with strong insecticidal properties across the three botanical inputs (Jatropha oil, aloe vera, and soapberry) are presented in Table 3. Oils like oleic acid and linoleic acid in jatropha oil are powerful larvicidal agents against *Aedes aegypti*, *Culex quinquefasciatus*, and agricultural pests (Azevedo *et al*., 2010; Sutthanont *et al*., 2010). From Soapberry (*Sapindus* spp.), the presence of triterpenoid saponins and limonoid compounds, including swietenolide derivatives and pongachin, aligns with previous studies describing their potent antifeedant and insect growth-regulatory activities against lepidopteran and dipteran pests (Chaieb, 2010; Koodalingam *et al*., 2011). The detection of D-limonene, a monoterpene hydrocarbon found in *Sapindus* spp., further supports its insecticidal and repellent properties (Nguyen *et al*., 2023). Aloe vera contributed largely to the profile of short-chain alcohols and aldehydes, including 1-pentanol, 1-hexanol, heptanal, octanal, nonanal, and 2-heptanone, which are known to result from enzymatic and oxidative degradation of unsaturated fatty acids present in aloe leaf gel (Al-Madboly *et al*., 2023). Collectively, these insecticidal fatty acids, sterols, triterpenoids, and monoterpenes underpin the pesticidal potential of the formulation. The complex mixture reflects the biochemical diversity of the combined extract, and its potential for pesticidal, antimicrobial, or therapeutic uses calls for further bioactivity-guided research. The classification and bioactivity of the chemical profile obtained in the present study (Table 4) are consistent with previously reported phytochemical compositions of *J. curcas* seed oil; unsaturated fatty acids, especially oleic and linoleic acids, dominate, along with diterpenoid phorbol esters and minor terpenoid fractions. Similar GC-MS profiles have been reported by Sauerwein *et al*. (1993); formulation's chemical relevance was confirmed by Verma *et al.* (2001) and Abdelgadir and Van Staden (2013).

Table 3: The main chemical constituents of Jatropha oil-based formulation

Retention time	Compound name	SI	RSI	Area counts (min)	% Peak area
4.95	1-Pentanol	846	898	144875.97	2.10
8.16	1-Hexanol	965	966	2170579.79	3.80
8.88	2-Heptanone	795	868	240117.83	1.50
9.22	Heptanal	858	896	190606.46	1.30
12.68	Octanal	883	964	327294.87	2.70
13.51	D-Limonene	948	949	16009838.28	27.60
40.60	Oleic Acid	835	849	8482647.58	14.90
41.72	2-Hydroxy-3-O-tigloyl-6 -O-acetylswietenolide	357	367	79878.37	0.90
52.865	Pongachin	671	803	214022.80	0.013
54.91	Linoleic acid ethyl ester	525	598	100112.15	18.40
15.96	Nonanal	915	922	691672.09	1.90

Table 4: Classification and bioactivity of major GC-MS identified compounds

Compound	Chemical class	Reported bioactivity
Linoleic acid	Polyunsaturated fatty acid	Membrane disruption, larvicidal (Sutthanont *et al*., 2010)
Oleic acid	Monounsaturated fatty acid	Cuticle penetration, neurotoxicity (Azevedo *et al.,* 2021)
D-Limonene	Monoterpene hydrocarbon	Neurotoxic, fumigant (Tapondjou *et al.,* 2010)

4. Discussion

4.1 Mechanism-based interpretation of insecticidal activity

The work of Bhattacharyya *et al.* (2022), supports the present findings, where they studied the efficacy of *J. curcas* against potato cutworm, *Agrotis ipsilon,* demonstrating a directly proportionate relationship between per cent mortality and concentration and exposure time. The soil dip method was used to test a few plant oils against white grub, *L. mansueta*, and termite, *O. obesus*. Dutta (2017), also found that neem oil @ 10% registered the highest mortality (80.35%), followed by Jatropha oil @ 12% (77.50%) and karanj oil @ 10% (76.70%) at 72 h, respectively. The highest concentration of jatropha oil (12%) resulted in the highest mortality, which confirm with the present investigation. Silva *et al.* (2012), tested *J. curcas* seeds and derivatives against grain insect pests, supporting this study. Powders and aqueous extracts from *J. curcas* seeds and pericarps were tested for toxicity against adults of *Sitophilus zeamais* and *Rhyzorpertha dominica* at LT_{50} and LT_{95}. All genotypes of *S. zeamais* and *R. dominica* showed the same toxic effect, and seed treatments killed more insects than pericarps (Silva *et al*., 2012). Findings of Ranger *et al.* (2009), also revealed the efficacy of botanicals based on LC_{50} and LC_{60} values against various species of white grubs, *viz*., *Rhizotrogus majalis, Anomala orientalis, Cyclocephala borealis,* and *Popillia japonica*. Armorex (84.5% sesame oil, 2.0% garlic oil, 2.0% clove oil, 1.0% rosemary oil, and 0.5% white pepper extracts) was the most potent of the eight biopesticides tested. Azatin, which contains 3% azadirachtin, was also poisonous to scarab larvae. The effect of *J. curcas* oil and its poisonous portion at 1, 5, 10, and 20% dilutions against *Microcerotermes beesoni* is consistent with Singh and Sushilkumar (2008). Crude karanjin extract induced 83.3% mortality after 2 h and 100% after 4 h. Jatropha seed cake resulted in 46.6% of termite mortality in 72 h. However, the crude active components of all cakes caused 100% mortality after 6 h. Mortality caused by phorbol esters was 80% in 4 h. According to Verma *et al.* (2001), *J. curcas* phorbol ester fraction and *Pongamia pinnata* oil were effective against *O. obesus*. The present investigation found that Jatropha oil-based formulations were most effective against the white grub and worker termite, which is consistent with Lateef *et al.* (2014), in which the highest wood protection was observed at *J. curcas* oil @ 20% concentration and termites were examined with 80, 50, and 20% phorbol ester. The most effective concentration (80%) killed the highest number of termites at the shortest exposure time. Non-soil dwelling insects worldwide have been shown to benefit from *J. curcas* seed oil and other extracts. Njom (2022) evaluated the effects of *J. curcas* leaf extracts on various stages of *A. aegypti*. After 96 h, the highest concentration (1000 µl) resulted in 100% mortality in all the stages except the second instar, with a mean mortality of 76%. Adjuvants (ethyl alcohol, soapberry, and aloe vera) used in preparing the formulation did not show any mortality in either of the tested insects, confirming the significant insecticidal effect of *J. curcas* seed oil. The probit regression analysis revealed a clear concentration mortality relationship of the Jatropha oil-based formulation against both *L. mansueta* and *O. obesus*, as indicated by the positive slopes of the regression equations across all exposure periods. The increase in slope values with exposure time, particularly from 48 h (0.669) to 120 h (0.552) in *L. mansueta* and from 6 h (0.802) to 72 h (0.713) in *O. obesus*, indicates enhanced toxic response and increased susceptibility of insects to the formulation over prolonged exposure. A steeper slope reflects greater homogeneity in population response and suggests that small increases in concentration produce substantial increases in mortality (Robertson *et al*., 2017). The relatively low standard error values of the regression coefficients in both the tested insects indicate high precision and reliability of the estimated slopes, confirming the consistency of the dose-response relationship. According to principles of probit analysis, smaller standard errors indicate reduced variability among replicates and greater confidence in LC_{50} estimation (Finney, 1971). Furthermore, the chi-square values were generally low and within acceptable limits, indicating a good fit between observed and expected mortality and confirming that the probit model adequately described the toxic response of the test insects. Only slightly higher chi-square values at later exposure periods may reflect increased biological variability due to progressive toxic effects. Insecticidal efficacy of Jatropha oil-based formulation can be attributed to multiple phytochemical classes acting through distinct biochemical and molecular pathways. Linoleic and oleic acids are known to disrupt insect cell membranes, interfere with respiratory enzymes, ultimately leading to paralysis and death (Sutthanont *et al*., 2010; Azevedo *et al*., 2021). Monoterpenes such as D-limonene exert neurotoxic effects by inhibiting acetylcholinesterase activity, resulting in hyperexcitation and knockdown in insects (Tapondjou *et al*., 2002). Phorbol esters, diterpenes of the phorbol class, in Jatropha seed oil imitate diacylglycerol, a protein kinase C activator that affects signal transduction pathways. Protein, DNA, cell differentiation, and gene expression are also affected by protein kinase C interference (Abdelgadir and Van Staden, 2013).

4.2 Safety considerations and non-target implications

Despite the demonstrated insecticidal efficacy, the safety profile of major constituents requires careful consideration. Phorbol esters are known for their tumour-promoting and inflammatory effects in mammals, causing direct exposure and necessitating the formulation optimization to reduce non-target risk (Abdelgadir and Van Staden, 2013). The persistence of fatty acids and monoterpenes in the environment is generally low due to rapid biodegradation, resulting in comparatively reduced ecological impact.

5. Conclusion

The present investigation showed the susceptibility of both *L. mansueta* and *O. obesus* to various concentrations of Jatropha oil-based formulation. Mortality of *L. mansueta* and *O. obesus* was due to the insecticidal action of the Jatropha oil-based formulation, which rose progressively with increasing concentration and exposure time.

Among all the different concentrations evaluated, the 7% concentration of Jatropha oil-based formulation showed more toxicity with the least LT_{50} value over the other concentrations against both the tested insects. The adjuvants of the formulation showed no mortality in the tested insects. The bioactivity of the formulation is primarily associated with specific phytochemicals, notably unsaturated fatty acids and monoterpenes, as recorded in the present study, which act synergistically through membrane disruption and neurotoxicity. These findings move beyond formulation-level efficacy and provide mechanistic insights into the pesticidal potential of the formulation.

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Author contributions

Shareen Tikhak: Investigation, Data curation, Analysis, Writing; Badal Bhattacharyya: Conceptualisation, Methodology, Review; Shimantini Borkataki: Methodology, Review and Editing; Partha Pratim Gyanudoy Das: Analysis and Editing; K. Sindhura Bhairavi: Review and Editing; Manoj Kumar Sarma: Review and Editing.

Conflict of interest

The authors declare no conflicts of interest relevant to this article.

References

Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. J. Econ. Entomol. **18**(2):265-267. http://dx.doi.org/10.1093/jee/18.2.265a

Abdelgadir, H.A. and Van Staden, J. (2013) Ethnobotany, ethnopharmacology and toxicity of *Jatropha curcas* L. (Euphorbiaceae): A review. S. Afr. J. Bot., **88**:204-218 https://doi.org/10.1016/j.sajb.2013.07.021

Al-Madboly, L.A.; Yagi, A.; Kabbash, A.; El-Aasr, M.A. and El-Morsi, R.M. (2023). Microbiota-derived short chain fatty acids in fermented Kidachi Aloe promote antimicrobial, anticancer, and immunomodulatory activities. BMC Microbiol., **23**(1):240. https://doi.org/10.1186/s12866-023-02981-z

Azevedo, F.R.D.; Bezerra, L.L.A.; Silva, T.I.D.; Silva, R.A.D. and Feitosa, J.V. (2021). Larvicidal activity of vegetable oils against *Aedes aegypti* larvae. Rev. Fac. Nac. Agron. Medellín., **74**(2):9563-9570. http://dx.doi.org/10.15446/rfnam.v74n2.91486

Bhagawati, S.; Bhattacharyya, B.; Mishra, H. and Gogoi, D. (2017). Chemical management of termites (*Odontotermes obesus* Rambur) in preserved setts of sugarcane (*Saccharum officinarum*). J. Entomol. Zool. Stud., **5**(1):856-859.

Bhattacharyya, B.; Bhagawati, S.; Das, P.P.G. and Devi, E.B. (2022). Effect of physic nut oil against potato cutworm, *Agrotis ipsilon*. J. Entomol. Res., **46**(1):73-76 http://dx.doi.org/10.5958/0974-4576.2022. 00011.1

Bhattacharyya, B.; Pujari, D.; Bhuyan, U.; Handique, G.; Baruah, A.A. L. H.; Dutta, S.K. and Tanaka, S. (2015). Seasonal life cycle and biology of *Lepidiota mansueta* (Coleoptera: Scarabaeidae): A serious root-feeding pest in India. Appl. Entomol. Zool., **50**(40):435-442. https://doi.org/10.1007/s13355-015-0349-4

Brown, V. K. and Gange, A. C. (1990). Insect herbivory insect below ground. Adv. Ecol. Res., **20**:1-58. https://doi.org/10.1016/S0065-2504 (08) 600 52-5

Chaieb, I. (2010). Saponins as insecticides: A review. Tunis. J. Plant Prot., **5**(1):39-50.

Chandel, R.S.; Chandla, V.K.; Verma, K.S. and Pathania, M. (2013). Insect pests of potato in India: Biology and management. In: Andrei A, Silvia I and Yulin Gao (Eds.), Insect Pests of Potato: Global Perspectives on Biology and Management. Academic Press Elsevier Inc., pp:227-270. http://dx.doi.org/10.1016/B978-0-12-386895-4.00008-9

Choudhury, P. (1999). Studies on the pests of *Camellia sinensis* L(O). Kuntze and their control in the tea agro-ecosystem in Barak Valley, Assam. Ph.D Thesis, Gauhati University, Assam, India.

Dutta, D. (2007). Bioassay of some plant oils against white grub, *Lepidiota mansueta* Burmeister (Coleoptera: Scarabaeidae) and Termite, *Odontotermes obesus* Rambur (Isoptera: Termitidae). M.Sc. Thesis, Assam Agricultural University, Jorhat.

Finney, D.J. (1971). Probit Analysis, 3rd Edition, Cambridge University Press, Cambridge. https://doi.org/10.1002/jps.2600600940

Koodalingam, A.; Mullainadhan, P. and Arumugam, M. (2011). Effects of extract of soapnut *Sapindus emarginatus* on esterases and phosphatases of the vector mosquito, *Aedes aegypti* (Diptera: Culicidae). Acta Trop., **118**(1):27-36. https://doi.org/10.1016/j.actatropica. 2011.01.003

Lateef, F.A.; Daudu, S.O.; Jere, P. and Yusuf, D. (2014). Insecticidal effect of *Jatropha curcas* oil phorbol esters on the nymph, adult cockroaches and termites. Int. J. Appl. Eng. Res., **3**(2):495-503.

Nguyen, Q.D.; La, Q.D.; Nguyen, N.N. and Nguyen, T.N.L. (2023). Green removal of unpleasant volatiles from soapberry (*Sapindus mukorossi*) extracts by two-phase microbial fermentation fortified with pomelo peel waste. RSC Adv., **13**(19):13282-13291. https://doi.org/10.1039/d3ra01858j

Njom, V.S. (2022). Insecticidal potency of leaf extract of *Jatropha curcas* L. on the developmental stages of dengue fever vector-*Aedes aegypti*. Asian J. Med. Sci., **4**(2):37-43.

Oloo, G. W. (1990). In: Edwards, R. and Mill, A.E. (Eds.), Termites in Buildings: Their Biology and Control. Int. J. Trop. Insect Sci., **11(2)**:261. https://doi.org/10.1017/S1742758400010663

Pardeshi, M.K.; Kumar, D. and Bhattacharyya, A.K. (2010). Termite (Insecta: Isoptera) fauna of some agricultural crops of Vadodara, Gujarat (India). Rec. Zool. Surv. India, **110**:47-59. https://doi.org/10.26515/rzsi/v110/i1/2010/158961

Pujari, D.; Bhattacharyya, B.; Mishra, H.; Gogoi, D. and Bhagawati, S. (2017). Field evaluation of some insecticides against white grub, *Lepidiota mansueta* (Coleoptera: Scarabaeidae), on potato (*Solanum tuberosum*) in Assam (India). Appl. Bio. Res., **19**(1):89-93.

Rahman, I.; Kode, A. and Biswas, S.K. (2006). Assay for quantitative determination of glutathione and glutathione disulfide levels using enzymatic recycling method. Nat. Protoc., **1**(6):3159-3165. https://doi.org/10.1038/nprot.2006.378

Ranger, C.M.; Reding, M.E.; Oliver, J.B., Moyseenko, J.J. and Youssef, N. N. (2009). Toxicity of botanical formulations to nursery-infesting white grubs (Coleoptera: Scarabaeidae). J. Econ. Entomol., **102**(1):304-308. http://dx.doi.org/10.1603/029.102.0140

Robertson, J. L.; Jones, M. M.; Olguin, E. and Alberts, B. (2017). Bioassays with arthropods. CRC Press.

Sauerwein, M.; Sporer, F. and Wink, M. (1993). Insect-toxicity of phorbol esters from *Jatropha curcas* seed oil. Planta Med., **59**(S1):A686-A686.

Silva, G.N.; Faroni, L.R.A.; Sousa, A.D. and Freitas, R.S. (2012). Bioactivity of *Jatropha curcas* L. to insect pests of stored products. J. Stored Prod. Res., **48**:111-113. https://doi.org/10.1016/j.jspr.2011.10.009

Singh, N.; Sushilkumar, A. (2008). Anti-termite activity of *Jatropha curcas* Linn. biochemicals. J. Appl. Sci. Envir. Manag., **12**(3):67-69. https://doi.org/10.4314/jasem.v12i3.55498

Solsoloy, A.D. (1995). Pesticidal efficacy of the formulated physic nut, *Jatropha curcas* L. oil on pests of selected field crops. Philipp. J. Sci., **124**(1):59-74.

Sutthanont, P.; Kanjanapothi, D. and Rukachaisirikul, V. (2010). Mosquito larvicidal activity of oleic and linoleic acids isolated from *Citrullus colocynthis* Linn. Schrad. Phytother. Res., **24(8)**:758-761. https://doi.org/10.1002/ptr.3018

Tapondjou, L.A.; Adler, C.L.A.C.; Bouda, H. and Fontem, D.A. (2002). Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain protectants against six-stored product beetles. J. Stored Prod. Res., **38**(4):395-402. https://doi.org/10.1016/S0022-474X(01)00044-3

Verma, M.; Pradhan, S.; Sharma, S.; Naik, S.N. and Prasad, R. (2001). Efficacy of karanjin and phorbol ester fraction against termites (*Odontotermes obesus* Rambur). Int. Biodeterior., **65**(6):877-882. https://doi.org/10.1016/j.ibiod.2011.05.007

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