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(RESEARCH ARTICLE)

EVALUATION OF THE LARVICIDAL ACTIVITY OF CRUDE STEM EXTRACTS OF *MUSA PARADISIACA* L. (MUSACEAE) AGAINST *AEDES AEGYPTI* LARVAE.

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ABSTRACT

This study evaluated the larvicidal activity of the stem extract of *Musa paradisiaca* (plantain), (Musaceae) against *Aedes aegypti* larvae. Fresh stem material was collected, dried and pulverized. The plant material (500g) was extracted with sufficient quantity of N-Hexane, Chloroform and methanol successively. The extracts were screened for phytochemicals using standard methods. The extracts were dried and used for the larvicidal assay. The larvicidal assay was done according to World Health Organization (WHO) guideline for larvicidal assay. 20 healthy larvae of 3rd and 4th instar were used for each concentration of the extract (0.5, 1, 2, 3, 4, and 5mg/ml) in triplicate including the control. The activity was monitored over a 72-hour period. The number of deaths after every 24 hours was observed and recorded. Percentage mortality and LC_{50} values were used to determine larvicidal activities. Results of the phytochemical screening showed the presence of tannins, saponins, phenolics, triterpenoids, and alkaloids. The results for the larvicidal assay showed that the N-Hexane extract gave the highest mortality after 72 hours with 100% mortality and LC50 and LC90 of 0.25 and 0.58mg/ml respectively. The chloroform extract also exhibits a 100% mortality and LC50 and LC90 of 0.4 and 1.0 mg/ml respectively after 72 hours, while the methanol extract showed 0% activity in the 5mg/ml after 72 hours. The result of this study showed that the N-Hexane and chloroform stem extract of *Musa paradisiaca* gave very good activities and could further be studied to isolate the bioactive compounds(s) with the larvicidal activity.

Keywords: *Musa paradisiaca*, Stem extract, Larvicide, *Aedes aegypti*, Phytochemicals.

1 INTRODUCTION

Diseases which are mosquito-borne continue to pose a serious global health burden, especially in tropical and subtropical regions where the environmental conditions favor the breeding and survival of mosquitoes. Among these, the *Aedes aegypti* has been identified as the primary vector responsible for the transmission of major arboviral diseases such as dengue fever, chikungunya, Zika virus, and yellow fever. According to the World Health Organization [1], these diseases account for millions of reported cases annually, which leads to high rates of morbidity and mortality, in some cases, particularly in underdeveloped countries with low-income regions and inadequate public health facilities.

The use of chemical pesticides or insecticides such as organophosphates and pyrethroids has been the standard practice in mosquito control. While effective, these compounds pose numerous challenges. Their persistent use in the environment has led to environmental pollution, bioaccumulation in non-target aquatic organisms such as “plants”. Health issues in humans such as respiratory issues when inhaled and irritation of the body when absorbed or comes in contact with the skin [2]. Additionally, the development of insecticide resistance in mosquito populations has further limited the long-term effectiveness of these chemicals [3]. These concerns have prompted scientists to explore safer, plant-based, and more sustainable alternatives.

Musa paradisiaca, commonly known as plantain is widely cultivated in West Africa, including Nigeria. *Musa paradisiaca* has traditionally been used in folk or traditional medicine for a variety of therapeutic purposes. Different parts of the plant, including the peels, leaves, and fruit, have been studied and shown to possess some insecticidal, antioxidant and antimicrobial properties [4].

However, one of the most underutilized parts of the plant is the stem, which is often discarded after harvest. Preliminary phytochemical investigations suggest that the pseudo stem contains bioactive compounds such as saponins, tannins, flavonoids, alkaloids, and phenolic substances [5]. The fruit peel has shown to possess larvicidal activities [6].

The aim of this study is to evaluate the crude stem extracts of *Musa paradisiaca* for larvicidal activities.

2 METHODS

2.1 Materials

Macerating jar, Analytical weighing balance, Test tubes, Test tube holder, Test tube rack Measuring cylinders, Water bath, Beakers, Cotton wool, Spatula, Conical flask, Ceramic crucibles, Sample bottles, Desiccator, Filter paper, Disposable plastic plates, Aluminum foil, Funnel, Retort stand, Clamps, Pipette, Muslin cloth.

2.2 Reagents

Conc. H2SO4, Acetic anhydride, Glacial acetic acid, Distilled water, Fehling’s reagent, Ferric chloride, 5% Aluminum chloride, Sodium Picric paper, Chloroform, Kedde A and B, Mayer's reagent, Hager's reagent, Dragendoff's reagent, 5% NaOH, 5% Ferric chloride, 10% ammonia Magnesium ribbon, Dilute HCL, N-Hexane (analytical grade), Chloroform (analytical grade) Methanol (analytical grade), Yeast and Biscuit.

2.3 Plant Collection

The stem of *Musa paradisiaca* was collected from a local farm in woji, Port-Harcourt, Rivers state, Nigeria. It was identified by Dr. Suleiman of the department of pharmacognosy and phytotherapy, faculty of pharmaceutical sciences, university of Port-Harcourt. It was deposited in the herbarium of the department with voucher number of UPHM0707.

2.4 Plant Preparation

After stem collection, the stem of the plant was cut into smaller pieces using a knife and dried under a shade in a secured environment for three weeks.

The dried stem barks were collected and taken to the departmental lab for pulverization with the aid of a mechanical grinder. The powders were collected and stored in a dry air tight container until time of extraction.

2.5 Successive Extraction of the Plant Material Using Maceration Method

The pulverized plant stem was taken to the lab to carry out a successive extraction using 3 solvents; N-hexane, chloroform and methanol ranging from non-polar, mid-polar and polar. The extraction was done by weighing 500g of the grounded *Musa paradisiaca* stem and transferred into a macerating jar.

A 2.5 liter of analytical grade N-Hexane was measured and transferred into the jar and the jar was closed and placed in a safe room away from sunlight. After the 24 hours, the solvent was drained out using a muslin cloth and the mark transferred back into the macerating jar and 2.5 liter of fresh N-Hexane was transferred into the mark, this process was done for 96 hours, with intermittent draining after every 24 hours in order to exhaust the extraction of N-Hexane on the mark.

The N-Hexane mark was air-dried for 24 hours and the same procedure done for the next solvent which was the chloroform until the extraction was exhausted. The Chloroform mark was air-dried for 24 hours and transferred into

the macerating jar. The last solvent for extraction which was methanol was transferred into the mark and left for 24 hours. The last extraction using methanol was done only once.

The individual extracts were obtained by putting them in weighed ceramic crucibles and placing them in a water bath at a controlled temperature of 40°c- 50°c to obtain the dried extracts of N-Hexane, chloroform and methanol respectively. After which the percentage yield of each was calculated.

2.6 Phytochemical Screening

Phytochemical screening was done according to the method by Harborne, 1984 [7]

2.7 Mosquito Collection.

Six ribbons of *Aedes aegypti* mosquito eggs were obtained from the National Airborne Research Centre Enugu, Nigeria. The eggs were hatched in the Department of Pharmacognosy and Phytotherapy of University of Port Harcourt by dispersing them into six plastic plates, containing warm water heated up by the sunlight and transferred to a cool dry room, sufficient quantity of yeast was added and kept at room temperature for 24 hours until they hatched into larvae.

Crumbs of biscuits were added which served as their food source till the larvae matured to the third instar stage.

2.8 Stock Solution

The stock solution of 10mg/ml was prepared for the extracts. Dissolution was facilitated in case of the Chloroform extract with the use of little DMSO (2ml). From this stock solution, a serial dilution was done for the various concentrations used for the assay.

2.9 Larvicidal Bioassay

The larvicidal assay was carried out according to WHO guidelines for larvicidal assay [8]. The assay was carried out in triplicate for each of the concentrations, along with a control for each of the concentration. The concentrations were 0.5, 1, 2, 3 and 4mg/ml for each of the N-Hexane, chloroform and methanol extracts. About 68 small plastic containers were used and 20 larvae was use for each container in a 100ml volume. The control was made of equal volume of water with the same number of larvae as is in those with the extract

The activity was monitored every 24 hours for 3 days. This was done by counting the number of dead larvae every 24 hours for 72 hours. The results were taken, recorded and analyzed statistically.

2.10 Statistical analysis

The results were analyzed using Ldp line software by Ehab (2013) [9] and Microsoft excel.

3 RESULTS

3.1 Percentage Yield

Weight of powdered plant material = 500g

Table 1: Percentage yield of the different stem extracts of *Musa paradisiaca.*

Extract	Weight of dried extract (g)	Percentage yield (%w/w)
N-hexane	35.92	7.2%
Chloroform	4.23	0.9%
Methanol	12.17	2.4%

Table one showed percentage yield of the extraction. The n-hexane gave the highest yield of 7.2%, while methanol gave the lowest yield of 2.4%

3.2 Results of Phytochemical Screening

The Phytochemicals detected are: alkaloids, flavonoids, triterpenoids, glycosides, tannins, saponins, and phenols.

3.3 Results of Larvicidal assay

Table 2: The larvicidal activity of the crude N-hexane stem extract of *Musa paradisiaca* on *Aedes aegypti* larvae after 72 hours

	24 hours			**48 hours**			**72 hours**		
Conc. mg/ml	% mortality	LC_{50}	LC_{90}	% mortality	LC_{50}	LC_{90}	% mortality	LC_{50}	LC_{90}
0.5	66.7 ± 20.4	0.40 mg/ml	2.9 mg/ml	83.4 ± 15.3	0.27 mg/ml	0.59 mg/ml	85 ± 13.2	0.25 mg/ml	0.58 mg/ml
1	73.4 ± 12.6			100.0 ± 0.0			100.0 ± 0.0		
2	88.4 ± 10.4			100.0 ± 0.0			100.0 ± 0.0		
3	96.7 ± 5.8			100.0 ± 0.0			100.0 ± 0.0		
4	95.0 ± 8.7			100.0 ± 0.0			100.0 ± 0.0		

Values for means are represented as mean of S.E.M (standard error of means)

From table 2 above the larvicidal activity is very high with LC_{50} of 0.24 mg/ml and LC_{90} of 2.9 within 24 hours and 100% mortality within 48 hours at concentration of 1mg/ml

Table 3: The larvicidal activity of the crude chloroform stem extract of *Musa paradisiaca*

	24 hours			**48 hours**			**72 hours**		
Conc. mg/ml	% mortality	LC_{50}	LC_{90}	% mortality	LC_{50}	LC_{90}	% mortality	LC_{50}	LC_{90}
0.5	28.3 ± 32.2	0.9 mg/ml	2.5 mg/ml	41.7 ± 24.8	0.6 mg/ml	1.3 mg/ml	66.7 ± 16.1	0.4 mg/ml	1.0 mg/ml
1	51.7 ± 19.7			80.0 ± 5.0			85.0 ± 5.0		
2	70.0 ± 26.5			100.0 ± 0.0			100.0 ± 0.0		
3	100.0 ± 0.0			100.0 ± 0.0			100.0 ± 0.0		
4	100.0 ± 0.0			100.0 ± 0.0			100.0 ± 0.0		

Values for means are represented as mean of S.E.M (standard error of means)

From table 2 above the larvicidal activity is very high with LC_{50} of 0.9 mg/ml and LC_{90} of 2.5 within 24 hours and 100% mortality within 48 hours at concentration of 2mg/ml

Table 4: The larvicidal activity of the crude methanol stem extract of *Musa paradisiaca* on *Aedes aegypti* larvae after 72 hours.

	24 hours			**48 hours**			**72 hours**		
Conc. mg/ml	% mortality	LC50	LC90	% mortality	LC50	LC90	% mortality	LC50	LC90
0.5	0	0 mg/ml	0 mg/ml	0	0 mg/ml	0 mg/ml	0	0 mg/ml	0 mg/ml
1	0			0			0		
2	0			0			0		
3	0			0			0		
4	0			0			0		

Table 4 above showed methanol extract having zero activity

4 DISCUSSION

The study evaluated the larvicidal activity of the stem extracts of *Musa paradisiaca* against *Aedes aegypti* larvae using three solvents of increasing polarity, n-hexane, chloroform, and methanol successively. The results showed clear variations in percentage yield, phytochemical composition, and larvicidal efficacy among the extracts.

The percentage yields obtained from the successive extraction of *Musa paradisiaca* stem n-hexane (7.2%), chloroform (0.9%), and methanol (2.4%) shows that the stem contains more non-polar compounds, as indicated by the high n-hexane yield. This differs from the findings of Adesanya *et al*. (2021) [10] on the root extract of the same plant, where methanol produced the highest yield (4.65%), followed by n-hexane (2.94%) and ethyl acetate (2.51%). Compared with their study, the stem yielded more n-hexane extract, suggesting a higher concentration of lipophilic constituents in the stem than in the root. The lower methanol yield in the stem indicates fewer polar compounds relative to the root. These differences highlight how phytochemical distribution varies between different parts of *Musa paradisiaca*, which in turn affects extraction efficiency and potential biological activity.

Phytochemical screening showed the presence of several bioactive compounds across the extracts, including alkaloids, flavonoids, triterpenoids, glycosides, tannins, saponins, and phenols. This result agrees with the findings of Onyenekwe *et al.* (2013),[11] who also analyzed *Musa paradisiaca* stem extrude and reported similar constituents such as tannins, saponins, flavonoids, alkaloids, glycosides, and phenolics. The consistency between both studies indicates that the plantain stem naturally contains a diverse range of bioactive compounds.

These phytoconstituents have been widely reported for their insecticidal and larvicidal properties. For instance, flavonoids can inhibit key enzymatic processes essential for larval survival [12]

The larvicidal bioassay demonstrated that the n-hexane and chloroform extracts exhibited very good larvicidal effects, while the methanol extract was found to be inactive throughout the 72-hour exposure period. For the n-hexane extract, mortality increased in a concentration and time-dependent manner, reaching a substantial mortality after 72 hours. The LC_{50} value of 0.25mg/mL after 72 hours indicates strong potency according to Komalamisra et al. (2005) [13] criteria, which classify LC_{50} < 50mg/L as high larvicidal efficacy. Similarly, the chloroform extract showed moderate to strong activity, with LC_{50} of 0.4mg/mL after 72 hours, confirming the presence of bioactive, compounds with larvicidal potential.

The methanol extract recorded 0% mortality across all concentrations and exposure periods, suggesting that highly polar compounds in *M. paradisiaca* stem possess little or no toxicity to *Aedes aegypti* larvae.

The findings of this study demonstrate that the stem extracts of *Musa paradisiaca* possess significant larvicidal activity against *Aedes aegypti* larvae, supporting earlier research, Joy and Madhavan (2022) [14] reported that both ripe and unripe fruit peels of *Musa paradisiaca* exhibited strong larvicidal effects against *Anopheles stephensi*, with mortality rates increasing in a concentration-dependent manner. The similarity between their results and the present study indicates that various parts of *Musa paradisiaca*, including the peel and stem contain bioactive chemical constituents capable of inducing larval mortality.

The larvicidal action observed in this research also corresponds with earlier botanical studies, particularly those involving *Allamanda cathartica* and *Ixora coccinea* (Lambert and Umunakwe, 2020; [15] Lambert and Sophia, 2021) [16], which also showed effective mortality against *Aedes aegypti* larvae within 72 hours. The present results therefore confirm that the plantain stem, which is an agricultural by-product often discarded after harvest, contains significant bioactive compounds with larvicidal potential.

Overall, the observed larvicidal activity validates the potential of *Musa paradisiaca* and supports its use as a source of natural bio-insecticides. Such plant-based larvicides could offer an eco-friendly, biodegradable, and cost-effective alternative to synthetic agents like temephos or malathion, which are known for environmental hazards and resistance issues.

5 CONCLUSION

This study demonstrated that the stem extracts of *Musa paradisiaca* possess significant larvicidal activity against *Aedes aegypti* larvae, with the n-hexane and chloroform extracts showing very high activity with dose and time-dependent effects, while the methanol extract exhibited little or no larvicidal activity. The larvicidal activity may do to the presence of one or more of the Phytochemicals found in the plant.

Effort should be made to isolated and characterize the compound(s) responsible for the larvicidal activity and possible development and for use in the fight against mosquito its borne diseases.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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There is no conflict of interest.

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