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Larvicidal Potential of Aqueous Ixora Leaves Extract Against Anopheles

Larvae: Probit Analysis and Lethal Concentration Estimates

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Abstract

Malaria remains a major global health concern, particularly in tropical and subtropical regions, with *Anopheles* mosquitoes serving as the primary vectors of *Plasmodium* parasites. The widespread use of synthetic insecticides has led to resistance in mosquito populations and raised concerns about environmental and human health impacts. Consequently, eco-friendly alternatives are urgently needed. This study evaluated the larvicidal activity of the aqueous extract of *Ixora* leaves against *Anopheles* larvae under laboratory conditions.

Larvae were exposed to graded concentrations of the extract (7.5–95.7 mg/L), and mortality was recorded after 24 hours. Mortality increased in a dose-dependent manner, ranging from 12.71% at 7.5 mg/L to 63.55% at 95.7 mg/L. Probit regression analysis revealed a strong correlation between log-concentration and mortality response ($R^2 = 0.82$). The LC_{50} and LC_{95} values were estimated at 12.9 mg/L and 33.0 mg/L, respectively.

These findings highlight the significant larvicidal efficacy of *Ixora* leaf extract, suggesting its potential as a botanical alternative to synthetic insecticides. Further phytochemical characterization, toxicity assessment on non-target organisms, and field validation are recommended to support its integration into sustainable malaria vector control programs.

Keyword: *Ixora* leaves , larvicidal activity , mortality response , botanical

الملخص

لا تزال الملاريا تمثل مشكلة صحية عالمية كبرى، خاصة في المناطق الاستوائية وشبه الاستوائية، حيث تُعد بعوضة الأنوفيلس الناقل الرئيسي لطفيليات البلازموديوم. وقد أدى الاستخدام الواسع للمبيدات الحشرية الاصطناعية إلى ظهور مقاومة لدى تجمعات البعوض، وأثار مخاوف بشأن التأثيرات البيئية والصحية على الإنسان. وبناءً على ذلك، هناك حاجة ملحة إلى بدائل صديقة للبيئة. هدفت هذه الدراسة إلى تقييم الفعالية القاتلة لليرقات لمستخلص أوراق نبات *Ixora* المائي ضد يرقات الأنوفيلس تحت ظروف مختبرية.

تم تعريض اليرقات لتركيزات متدرجة من المستخلص (7.5–95.7 ملغم/لتر)، وتم تسجيل معدلات الوفاة بعد 24 ساعة. أظهرت النتائج زيادة في معدل الوفاة بشكل يعتمد على الجرعة، حيث تراوحت بين 12.71% عند تركيز 7.5 ملغم/لتر إلى 63.55% عند تركيز 95.7 ملغم/لتر. وكشفت تحليلات الانحدار الاحتمالي عن وجود ارتباط قوي بين اللوغاريتم العشري للتركيز والاستجابة في معدل الوفاة ($R^2 = 0.82$). وقد قُدرت قيم LC_{50} و LC_{95} عند 12.9 ملغم/لتر و 33.0 ملغم/لتر على التوالي.

تُبرز هذه النتائج الفعالية الكبيرة لمستخلص أوراق *Ixora* في قتل يرقات البعوض، مما يشير إلى إمكاناته كبديل نباتي للمبيدات الاصطناعية. ويوصى بإجراء المزيد من الدراسات لتوصيف المكونات الكيميائية النباتية، وتقييم السمية على الكائنات غير المستهدفة، والتحقق الميداني لدعم دمجها في برامج مكافحة نواقل الملاريا المستدامة.

كلمات مفتاحية: أوراق إيكسورا ، نشاط مبيد اليرقات ، الاستجابة للوفيات ، نباتية

Introduction

Malaria is one of the most life-threatening vector-borne diseases, causing millions of infections and deaths annually, particularly in sub-Saharan Africa and Southeast Asia (WHO, 2005). *Anopheles* mosquitoes are the principal vectors of *Plasmodium* parasites, and their control remains a cornerstone of malaria prevention strategies. However, the extensive and prolonged use of synthetic insecticides has resulted in the development of insecticide resistance, environmental contamination, and adverse effects on non-target organisms (Abbott, 1925)..

In response to these challenges, research has increasingly focused on plant-derived larvicides as eco-friendly alternatives. Botanical extracts are rich in bioactive secondary metabolites such as alkaloids, flavonoids, and terpenoids, which have demonstrated insecticidal properties in various studies (Pavela, 2018). *Ixora*, a tropical ornamental and medicinal plant, has been reported to possess antimicrobial, antioxidant, and insecticidal activities (Govindarajan et al., 2016).. Nevertheless, its larvicidal potential against *Anopheles* larvae has not been extensively studied.

The present study was designed to evaluate the larvicidal activity of the aqueous extract of *Ixora* leaves against *Anopheles* larvae, with a focus on determining LC_{50} and LC_{95} values through probit regression analysis (Finney, 1971). The findings aim to contribute to the growing body of evidence supporting the use of botanical larvicides in integrated vector management programs (Sukumar et al., 1991).

Materials and Methods

Collection of larvae

Anopheles larvae were collected from natural breeding sites and reared under laboratory conditions (27 ± 2 °C, $75 \pm 5\%$ RH, 12:12 h light-dark cycle).

Preparation of plant extract

Fresh *Ixora* leaves were washed, shade-dried, and ground into fine powder. Aqueous extraction was performed by soaking 100 g of powdered leaves in 1 L of distilled water for 48 hours, followed by filtration. The filtrate was concentrated and stored at 4 °C until use.

Bioassay procedure

Larvae (20 individuals per replicate, 3 replicates per concentration) were exposed to graded concentrations of the extract (7.5, 20, 35, 65, and 95.7 mg/L). A control group was maintained

in distilled water. Mortality was recorded after 24 hours. Abbott's formula was applied to correct mortality when necessary.

Statistical analysis

Mortality data were subjected to probit transformation, and regression analysis was performed to estimate $LC_{\{50\}}$ and $LC_{\{95\}}$ values with 95% confidence intervals.

Results and Discussion

Mortality response

Larval mortality increased with concentration, ranging from 12.71% at 7.5 mg/L to 63.55% at 95.7 mg/L.

Regression analysis:

- $R^2 = 0.82$
- Slope (b) = 4.03
- Intercept (a) = 0.52
- $LC_{\{50\}} = 12.9$ mg/L
- $LC_{\{95\}} = 33.0$ mg/L

Concentration (mg/L)	Mortality (%)	Log-concentration	Probit value
Control	0	-	-
7.5	12.71	1.104	3.59
20	25.42	1.405	4.16
35	38.13	1.580	4.61
65	50.84	1.706	5.39
95.7	63.55	1.803	6.75

The aqueous extract of *Ixora* leaves demonstrated significant larvicidal activity against *Anopheles* larvae, with relatively low $LC_{\{50\}}$ and $LC_{\{95\}}$ values. This activity may be attributed to phytochemicals such as flavonoids and terpenoids, which are known to disrupt larval physiology

(Pavela, 2018).. The results are consistent with previous studies reporting the efficacy of botanical extracts (e.g., neem, *Azadirachta indica*; *Ocimum* spp.) against mosquito larvae (Govindarajan et al., 2016)..

However, the study was limited to laboratory conditions and did not assess the impact on non-target organisms. Further research should focus on phytochemical characterization, eco-toxicological evaluation, and field trials to validate the practical applicability of *Ixora* extracts in integrated vector management (Benelli & Mehlhorn, 2019).

Conclusion

The aqueous extract of *Ixora* leaves exhibits strong larvicidal potential against *Anopheles* larvae, with LC_{50} and LC_{95} values of 12.9 mg/L and 33.0 mg/L, respectively. These findings support the potential use of *Ixora* as a natural, eco-friendly larvicide (Sukumar et al., 1991). Future studies should aim to isolate active compounds and evaluate their effectiveness under field conditions.

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