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The Influences of the Water Extract of *Aloe Vera* (L) Burm.f. on the Life Period of *Culex pipiens* Larvae

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Abstract

Culex mosquitoes are important vectors of several human and animal diseases, including filariasis and various forms of encephalitis, making the control of their larvae a public health priority. In this study, Culex pipiens larvae were collected from a pond within the botanical garden of the Ibn Al-Haitham College of Education for Pure Sciences, and Aloe vera leaves were also collected from the same college's gardens. Aqueous *Aloe vera* extract was prepared and tested for its larval bactericidal activity against *Culex pipiens* mosquitoes under controlled laboratory conditions. Larvae of all four larval stages were exposed to a range of extract concentrations (10%, 15%, 20%, and 25%) in five replicates, each containing 50 larvae. Larval mortality was observed after 12 and 24 hours of exposure at 25 ± 2°C. The results demonstrated a direct relationship between extract concentration and larval mortality. While low concentrations (0.5-1.5%) showed little or no effect, higher concentrations (10-25%) significantly increased larval mortality, reaching 100% at 25% within 24 hours. These results confirm the effectiveness of aqueous *Aloe vera* extract in killing larvae, demonstrating its time- and dose-dependent efficacy. In conclusion, *Aloe vera* extract represents a good and environmentally safer alternative to chemical pesticides used in local markets for mosquito control, as it provides a biodegradable and non-toxic alternative, reducing reliance on chemical insecticides. Further studies on its active phytochemical components and mode of action are recommended to support its potential use in integrated vector management programs.

Keywords: *Aloe vera*, *Culex pipiens*, Larvicidal action, Mosquito management, Extraction

1. Introduction

Mosquito-borne diseases remain a major global public health challenge, causing millions of infections annually. Among these vectors is *Culex pipiens*, one of the most widespread species, inhabiting both rural and urban environments and serving as a primary vector for numerous pathogens, including West Nile virus, lymphatic filariasis, and other arthropod viruses. Its environmental adaptability and high reproductive capacity have enabled it to maintain stable populations even under adverse environmental conditions, making it a persistent public health threat and a priority target for vector control programs worldwide [1, 2].

Mosquitoes have evolved resistance to most classic insecticides, underscoring the need for the selection of environmentally friendly mosquito control ways [3,4].

The failure to find new groups of pesticides has led many scientists to discover new studies to search for alternative biological and economic means [5].

Some studies tested the effect of the growth regulator Dimilin on the larval stages of *Culex pipiens* mosquitoes, and the same research compared the effect of the growth regulator Dimilin on different larval stages and its comparison with the biocide Bacillus thuringiensis israeliensis [6].

Also, some scientists and researchers have used plant extracts to combat different types of insects, and others have used them in experiments to gain and enhance immunity in laboratory animals [7].

Traditional mosquito control strategies have largely relied on synthetic chemical insecticides. However, the overuse of these compounds has led to widespread insecticide resistance among mosquitoes, as well as negative impacts on non-target organisms and the environment [8]. These limitations have increased the global demand for alternative mosquito control methods that are environmentally friendly, biodegradable, and economically sustainable. Therefore, plant-derived larvicides have emerged as promising options due to the abundance of phytochemicals, the diversity of their mechanisms of action, and their lower environmental risks compared to synthetic pesticides.

Aloe vera is a medicinal plant known for its different therapeutic effects and its active antibacterial, antifungal, and antioxidant properties, the functional combinations in *Aloe vera* contain anthraquinones like aloin and emodin, saponins, flavonoids, and phenolic combinations, which damage the cell wall of the larva; on the other hand stop the enzyme action, and affect oxidative stress in the bug [9,10].

Aloe vera leaves can be used as organic fertilizer, adding nutrients to other plants and contributing to improved productivity, it also plays an important environmental role in combating desertification due to its high tolerance to drought and harsh conditions, which helps stabilize the soil [11-13].

It is used in the manufacture of underwear and socks in some countries for its odor absorption and antibacterial properties, so parts of the plant can be used as livestock feed, providing a food source for animals [14-16].

The aim of this current study indicate the significance of a water extract of *Aloe vera* contra the four larval phases of *Culex* mosquitoes under lab conditions.

2. Materials and Methods

2.1. Larval Collection

Culex pipiens larvae were collected from stagnant water sources in different gardens of College of Education for Pure Sciences Ibn-AL-Haitham. Larvae were identified using standard taxonomic keys [17,18].

2.2. Collected *Aloe vera* plants

Fresh *Aloe vera* leaves were collected from different gardens of College of Education for Pure Sciences Ibn Al-Haitham/ University of Baghdad Baghdad- AL-Adamiyah, Iraq (33.3681782633508,44.36875016603921) followed the way of collected by [19, 20] and reached scrutiny for further identification using the Flora of Turkey [21].

2.3. Preparation of Aqueous *Aloe vera* Extract

Aloe barbadensis leaves were thoroughly washed with distilled water and then air-dried. The outer peel was removed, and the inner gel was carefully collected. 100 g of fresh gel was thoroughly blended using an electric mixer and then mixed with 100 mL of distilled water (1:1, w/v). The mixture was stirred with a magnetic stirrer at 50°C for 30 minutes, and then filtered through sterile cotton cloth to obtain the crude aqueous extract (100% concentrated solution). From the original solution, four working concentrations (10%, 15%, 20%, and 25%) were prepared by diluting them with distilled water.

2.4. Experimental Design and Control Groups

Four larval stages (instars 1-4) were tested separately. For each concentration, 50 larvae of each stage were exposed to 100 mL of the test solution in single-use plastic cups, with five replicates per treatment. Two control groups were established:Negative control group: Larvae exposed to distilled water only and Positive control group: Larvae exposed to a larvicidal compound.[22].

2.5. Mortality Assessment

Larval deaths were recorded after 12, 24, 48, and 72 h of exposure. Larvae were considered dead when they showed no movement in response to gentle examination. Mortality rates were calculated and corrected using Abbott's formula where necessary.

3. Results

The larvicidal activity of aqueous *Aloe vera* extract was evaluated against the four larval instars (L1–L4) of *Culex pipiens* at four concentrations (10%, 15%, 20%, and 25%) over exposure periods of 12, 24, and 48 hours. The results showed a clear concentration- and time-dependent increase in larval mortality across all instars.

3.1 First Instar Larvae (L1)

Mortality rates increased progressively with both concentration and time. At 10% concentration, mortality reached 30% at 12 hours, 50% at 24 hours, and 100% at 48 hours. A similar trend was observed for higher concentrations, with complete mortality (100%) achieved faster at 20% and 25%.

3.2 Second Instar Larvae (L2)

Second instar larvae exhibited a slightly lower sensitivity compared to L1. At 15% concentration, mortality reached 20% at 12 hours, 50% at 24 hours, and 100% at 48 hours. The 25% treatment caused 100% mortality after only 24 hours of exposure.

3.3 Third Instar Larvae (L3)

Third instars showed moderate resistance to the extract. At 10%, mortality was only 20% after 12 hours and rose to 75% at 48 hours. Complete mortality was only achieved with 25% concentration at 48 hours. The response curve was notably flatter compared to younger instars.

3.4 Fourth Instar Larvae (L4)

The fourth instar was the least affected by the extract. At 10% concentration, mortality remained below 50% even after 48 hours. However, 25% concentration induced mortality rates up to 60% at 24 hours and 100% at 48 hours. This indicates reduced susceptibility in more developed larvae.

3.5 Overall Trend

The data reveal that the effectiveness of *Aloe vera* extracts increases with both concentration and duration of exposure. Younger instars (L1, L2) were more susceptible than older ones (L3, L4). The highest mortality (100%) was consistently observed at 25% concentration across all instars by the end of the 48-hour period.

3.6 Sub-lethal Concentrations and Comparative Analysis

Additional bioassays were conducted using lower concentrations (0.5%, 1.0%, and 1.5%) to evaluate sub-lethal effects. Across all larval instars, no significant mortality was observed at these concentrations after 24 hours of exposure.

Table 1. Effect of low and high concentrations of *Aloe vera* on *Culex pipiens* mosquitoes.

Features	**Low Concentrations (0.5%–1.5%)**	**High Concentrations (10%–25%)**
Larvicidal efficacy	Negligible or absent	High (up to 100% mortality)
Onset of mortality	Not observed within 24h	Rapid, within 12–24h
Threshold effect	Below effective threshold	Exceeds lethal threshold
Environmental safety margin	Wide, low impact	Requires optimized application
Practical application	Ineffective for control	Suitable for larvicide formulations

4. Discussion

The compare among the sub-mortal concentrations 0.5%-1.5% and increased concentrations 10%-25% of *Aloe vera* extract for bug larvae showed important distinctions in larval death-rate. The Lower concentrations conduct few death-rate after run out 24 hours of therapy with the lower concentration. Contrarily, the heightened concentrations of *Aloe vera* extract revealed an increased death-rate in 100% in 25% concentration through 24-48 hours. These results are like

those of previous studies, as [23], and also agree with [24], who showed larvicidal activity of Aloe ferox against *Culex pipines*.

Sub-lethal concentrations of 0.5%, 1%, and 1.5% occur in high larval death rates after 24 hours of vulnerability through all stages. The absence of a significant impact at these concentrations most likely indicates a minimum dose for larval death, which has the necessary substances for determining the proper dose that causes larval death.

[25,26] also confirmed this result, discovering improved effectiveness when mixing *Aloe vera* with *Bacillus sphaericus*, the actuality of bioactive mixes such as phenolics aloin, emodin, flavonoids, saponins, and tannins in *Aloe vera* may present its larvicidal activity, these compounds are damage midgut epithelial cells and inhibit vital enzymatic processes also and disrupt transcription leading to larval death.

The data of research shows that the water extract of *Aloe vera* displayed effective larvicidal activity contra *Culex pipiens* mosquito larvae, and the death-rate was straight proportionate to both the extract concentration and the period of exposition, also today, some reports suggest the peels of *Aloe vera* can ward off bugs, acting as a natural insecticide, and the bioactive compounds in extracts from the peels deter insects from feasting on crops. [27,28]. The decreased exposure of later-stage larvae (L3 and L4) may be due to improved cuticle thickness or developed physiological reasons, some home gardeners set out to explore the possibility of recycling the peels of *Aloe vera* to evolve a natural pesticide that could help planters in areas where insects can be a main threat, such as regions of Africa, the tropical and subtropical regions of the Americas, and the maize and millet fields in India. The new application as a pesticide could also provide an environmentally friendly alternative for disposing of the peels and create additional revenue streams for *Aloe vera* producers, and the goal is to recycle this waste in a meaningful way while making aloe production greener and more sustainable [29,30].

5. Conclusion

The work indicated that the water extract of *Aloe vera* had an obvious larvicidal activity against all phases of *Culex pipiens* larvae, with death rates rising depending on concentration and time. These findings support the potential use of *Aloe vera* as a botanical larvicide in mosquito control programs and highlight the importance of dose optimization for practical field applications, particularly at concentrations above 1.5%, as lower doses (0.5%–1.5%) showed negligible effects within 24 hours.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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