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Larvicidal activity of onion peels, garlic peels and papaya leaf extract against *Culex* mosquitoes

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Abstract
Mosquitoes of the genus *Culex* are crucial vectors of numerous diseases, which includes lymphatic filariasis, Japanese encephalitis, and West Nile fever. The enormous use of artificial pesticides has caused environmental worries and the improvement of insecticide resistance, necessitating the look for green options. The observes evaluated the larvicidal hobby of aqueous extracts of onion *(Allium cepa)*, garlic (*Allium sativum*), and papaya (*Carica papaya*) against *Culex* mosquito larvae at one-of-a-kind concentrations (10%, 20%, 50%, 70%, 90%, and 100%) and publicity periods (1, 6, 12, 18, and 2 hours). Larval mortality multiplied with each attention and publicity time for all extracts. Garlic extract exhibited the best larvicidal hobby, reaching whole mortality (100%) at 90% and 100% concentrations inside 1 hour of publicity. Papaya extract confirmed slight effectiveness, even as onion extract verified relatively decrease larvicidal hobby. Mean mortality values ranged from 1.50 ± 0.80 to 5.00 ± 0.00 for garlic, 2.50 ± 0.91 to 3.80 ± 0.45 for papaya, and 1.80 ± 0.79 to 0.10 ± 0.45 for onion extracts. Two-manner ANOVA discovered full-size results of each attention ($F = 5.156$, $p = 7.01 \times 10^{-7}$) and publicity time ($F = 55.838$, $p = 6.71 \times 10^{-24}$) on larval mortality. The findings suggest that plant-primarily based totally extracts, especially garlic, own robust larvicidal capacity and might function environmentally secure options for the manipulate of *Culex* mosquito populations.

Keywords: *Culex*, biopesticides, garlic, mortality

Introduction

Mosquitoes are vectors of many important diseases such as malaria, dengue, West Nile virus, yellow fever, filariasis, and encephalitis, and thus they pose a great threat to human and animal health. Effective mosquito management requires not only an integrated mosquito management concept in which all appropriate methods for control are used, but also knowledge of the biology and ecology of the target organisms (Becker *et al.,* 2020) [3]. Their adaptability and close association with human settlements contribute to suicide disease transmission cycles throughout the country.

According to the World Health Organization, mosquitoes are dangerous to humans because they spread many diseases. They carry harmful parasites and viruses that cause illnesses such as malaria, filariasis, dengue fever, and West Nile fever. These diseases create major health problems and economic losses worldwide. (Hashem *et al*., 2017) [5].

In breeding sites, co-occurrence of different mosquito species may result in interspecific competition at the larval stage for scarce resources such as food and space. Competitive interactions may influence the developmental rate, survival and behaviours (predation and cannibalism) of the mosquito larvae, which in turn influence the species composition and abundance in the ecosystem. (Giatropoulos *et al.,* 2010).

Historically, *Culex* -borne diseases have demonstrated both endemic persistence and epidemic outbreaks across different regions of the country. Lymphatic filariasis was documented in India as early as the late nineteenth century and gradually became endemic in many coastal and riverine states. Japanese encephalitis emerged as a major public health threat in the mid-twentieth century, with the first confirmed outbreak reported in 1955 in Tamil Nadu. Large-scale epidemics followed in 1973 in West Bengal and in 1978 in Uttar Pradesh, establishing the Gangetic plains as a high-risk endemic region. Recurrent outbreaks have since been recorded in states such as Bihar and Assam, with the 2005 epidemic in Uttar Pradesh marking one of the most severe episodes, predominantly affecting children. These recurring epidemics highlight the persistent vulnerability of affected regions despite ongoing vaccination and surveillance efforts. (Rahmayanti *et.al* 2022) [12].

The Philippines experienced the worst year of the Dengue epidemic last 1998. As the fastest spreading vector-borne disease, dengue became endemic in the Philippines along with malaria, which is rampant in Palawan. (Tayag, E. 1998) [7].

Garlic is an important dietary and medicinal plant in the history of humankind. Since ancient times it has been used as food and medicine. It belongs to the family Amaryllidaceae and its botanical name is *Allium sativum*. It had been used in ancient Greece (Hippocrates), Egypt, Rome, India, China and Japan for multiple indications including performance enhancement, pulmonary and digestive complains, abnormal growth, cardiovascular health, emotional health, potency and as an anti- infective agent due to being enriched with medicinal effects. (Rivlin *et al*., 1998)

It is also among the oldest of all cultivated plants. It has been used as a spice, food and folklore medicine for over 4000 years and is the most studied medicinal plant (Milner, 1996) [8].

Conventional control measures have relied heavily on synthetic insecticides to reduce mosquito populations. While initially effective, prolonged, and indiscriminate use has led to insecticide resistance, environmental contamination, and harmful effects on non-target organisms. Such limitations highlight the urgent need for sustainable, eco-friendly alternatives that can complement existing vector control strategies. Effectiveness of plant derived secondary compounds, such as saponine (Pelah D *et.al*, 2002) [11].

The pawpaw plant, *Carica papaya* is popularly known among rural Africans as a major source of medicinal and insecticidal agents. *C. papaya*, of the family Caricaceae, is a fast-growing tree widespread throughout Africa. (Afolayan 2003) [1].

In folk medicine, *C. papaya* is popularly used in treatment of different maladies: the latex as anti-septic for healing burns, the leaves for removing elephantoid growths, the roots for treating syphilis, the seeds as anti-helminthic, etc. (Hewitt *et.al.* 2002).

Ethnomedically, *C. papaya* is a strong amibicide (Reed 1976), and (Anibijuwon and Udeze 2009) [2] demonstrated significant anti-microbial activities of the leaf and root extracts on some pathogenic organisms of clinical importance in Southwestern Nigeria.

The failure of chemotherapy in controlling mosquito-borne diseases (Mittal and Subbarao 2003) has reinforced the belief that the only way to sustainably reduce the burden of these diseases to tolerable levels is by attacking the vector mosquitoes. In this respect, synthetic chemical insecticides have been primarily, but unsuccessfully, used to control mosquitoes, particularly the adult stage, either as aerial sprays or impregnated bed nets. (Shallan *et al*. 2005) [14].

Though the medicinal importance of *C. papaya* has been well documented there is paucity of information on its potential insecticidal activity especially against mosquitoes. Therefore, the present study was carried out to investigate the larvicidal and Insect Growth Regulator activities of *C. papaya* on *Culex* spp., a major vector of some arboviral and filarial diseases. Olayemi et.al (2013) [10].

Adoption of integrated mosquito management approach for effective and efficient biological control on mosquito (Ali *et al*., 2010). The biological control does not cause chemical pollution to human alongside environments however it is specifically toxic to specific targeting species not affecting the non-target organisms (Bansal *et al*., 2012)

In recent years, plant-based biopesticides have gained attention as promising, biodegradable, and cost-effective tools for mosquito management. Agricultural waste materials such as onion peels, garlic peels, and papaya leaves contain bioactive phytochemicals with potential larvicidal properties. Utilizing these natural resources not only reduces environmental impact but also promotes waste vaporization and community-level participation in vector control.

The present study investigates the larvicidal efficacy of selected plant extracts against *Culex* mosquitoes, with findings indicating that onion peel extract exhibits the highest toxic activity in curbing larval growth. By integrating historical understanding of *Culex* -borne epidemics in India with innovative botanical interventions, this research seeks to contribute toward safer, sustainable, and locally adaptable strategies for reducing the burden of mosquito-borne diseases.

Materials and Methods

Experimental design

The experimental design was random. It includes plastic sampling bottles in which the solution is filled and larvae are introduced.

Preparation of Solution

1. In this experiment, onion peels, garlic peels and fresh papaya leaves were collected.
2. They were washed well with distilled water to remove dirt. After washing, they were soaked in water at room temperature.
3. Once they got fermented, they were ground in a solution.
4. Each solution was mixed with water to prepare the extract.
5. Mosquito larvae were collected from stagnant water.
6. Healthy and active larvae were selected for the experiment.
7. Different concentrations were prepared:
   Onion peel extract – 10%, 20%, 50%, 70%, 90% and 100%
   Garlic peel extract – 10%, 20%,50%, 70%, 90% and 100%
   Papaya leaf extract – 10%, 20%, 50% and 70%.
8. Five larvae were placed in each concentration for 24 hours.
9. Observations were taken at 1 hour, 6 hours, 12 hours, 18 hours, and 24 hours.
10. If the larvae did not move when bottle is shaken gently, they were considered dead.

Fig 1: Material used during experiment

Fig 2: *Culex* mosquito larva

Fig 3: Larvae introduced into different extracts at different concentration with replica

Results

Table 1: Toxicity effect of different concentration of solutions against *Culex sp*. larvae at different HATs (Extracts, doses, period)

Extract	Concentration	1 hour	6 hours	12 hours	18 hours	24 hours	Mean Mortality ± SE
Onion	10%	0	0	0.5	3.5	5	1.80 ± 0.79
Onion	20%	0	0	2.5	3.5	5	2.20 ± 0.68
Onion	50%	0	1	2.5	3.5	5	2.40 ± 0.63
Onion	70%	0	2	2.5	3.5	5	2.60 ± 0.58
Onion	90%	0	1.5	4.5	5	5	3.20 ± 0.60
Onion	100%	1.5	4	5	5	5	4.10 ± 0.45
Garlic	10%	0	0	0	2.5	5	1.50 ± 0.80
Garlic	20%	0	0	1.5	3	5	1.90 ± 0.66
Garlic	50%	0	1.5	3.5	5	5	3.00 ± 0.52
Garlic	70%	0	2.5	5	5	5	3.50 ± 0.45
Garlic	90%	5	5	5	5	5	5.00 ± 0.00
Garlic	100%	5	5	5	5	5	5.00 ± 0.00
Papaya	10%	0	0	2.5	5	5	2.50 ± 0.91
Papaya	20%	0	2.5	5	5	5	3.50 ± 0.67
Papaya	50%	0	3.5	5	5	5	3.70 ± 0.50
Papaya	70%	0	4	5	5	5	3.80 ± 0.45

The larvicidal pastime of onion, garlic, and papaya extracts against *Culex* mosquito larvae extended with each attention and publicity time. Mortality changed into lowest in the course of the preliminary 1–6 hours of publicity and regularly extended, attaining most tiers after 2 hours.

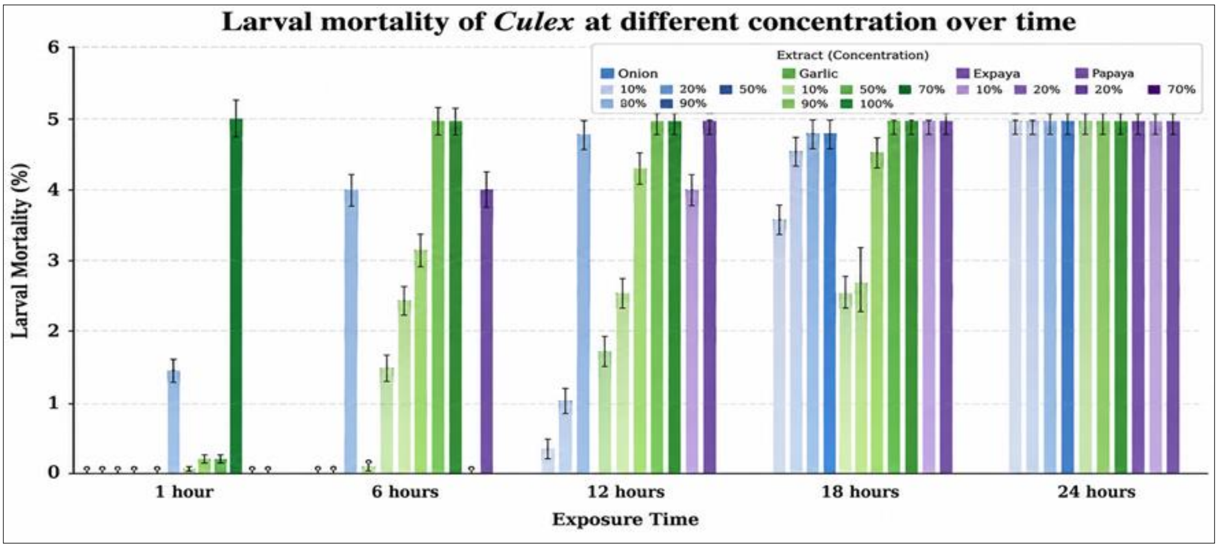
Among the onion extract treatments, imply larval mortality ranged from 1.80 ± 0.79 at 10% attention to 10 ± 0.5 at 100% attention. Complete mortality (five larvae) changed into found at 2 hours for all concentrations, despite the fact that better concentrations produced quicker larval death.

Garlic extract exhibited the very best larvicidal efficacy. Mean mortality extended from 1.50 ± 0.80 at 10% attention to five.00 ± 0.00 at each 90% and 100% concentrations. At those concentrations, 100% mortality changed into completed inside the first hour and maintained at some stage in the remark period, indicating a fast-poisonous impact on *Culex* larvae.

Papaya extract additionally proven sizable larvicidal pastime. Mean mortality values ranged from 2.50 ± 0.91 at 10% attention to 3.80 ± 0.5 at 70% attention. Mortality extended regularly with attention and publicity time, with entire larval mortality being found with the aid of using 18–24 hours at better concentrations.

Two-manner ANOVA discovered distinctly considerable variations amongst treatments. The impact of extract attention changed into considerable ($F = 5.156$, $p = 7.01 \times 10^{-7}$), because the calculated F-price handed the important F-price ($F_{crit} = 1.802$). Similarly, the impact of * time (columns changed into distinctly considerable ($F = 55.838$, $p = 6.71 \times 10^{-24}$), with the F-price substantially exceeding the important price ($F_{crit} = 2.337$). These consequences suggest that each attention and publicity period substantially motivated larval mortality.

Overall, garlic extract confirmed the most powerful larvicidal pastime against *Culex* larvae, observed with the aid of using papaya and onion extracts. The findings recommend that those plant extracts, especially garlic, own promising capacity as green botanical larvicides for mosquito control.



Graph 1: Mean mortality of *Culex* larvae in different extract at different concentration

Statistical Analysis

Microsoft Excel and SPSS were used to perform the ANOVA analysis. Concentration showed a significant effect ($F = 5.156$, $p = 7.01 \times 10^{-7}$), while exposure time had a highly significant effect ($F = 55.838$, $p = 6.71 \times 10^{-24}$). These results indicate that larval mortality increased significantly with increasing extract concentration and duration of exposure. To evaluate treatment means and find significant variations across treatments, Duncan's Multiple Range Test (DMRT) was utilized.

Discussion

The present investigation demonstrated significant larvicidal activity of Onion peel extract, Garlic peel extract, and Papaya leaf extract against *Culex* mosquito larvae. Mortality increased with increasing concentration and exposure period, indicating a dose-dependent and time-dependent toxic effect of the plant extracts.

Among all the tested extracts, the garlic peel extract demonstrated the highest larvicidal activity. Complete larval mortality was observed at 90% and 100% within 1 hour. The strong larvicidal activity of garlic may be due to the presence of sulfur-containing bioactive compounds such as allicin, diallyl sulphides and ajoene that interfere with the physiological and metabolic activities of mosquito larvae. Similar results were observed in some studies which showed the potent larvicidal activities of plant derived compounds against *Culex quinquefasciatus* and other mosquito vectors. (Samuel Tennyson *et.al;* 2012).

C. papaya showed presence of alkaloid, flavonoid, saponins, glycosides etc in the extract of *C. papaya* leaves; and these compounds have been reported to possess high larvicidal activities against different species of mosquitoes. (Imaga *et.al;* 2010) [6].

The larvicidal activity of onion peel extract was comparatively less than garlic and papaya extracts. In low concentrations, mortality was low in the first hours, but increased gradually with time and 100% mortality was reached after 24 hours.

Conclusion

The present study revealed that Garlic peel extract, Papaya leaf extract and Onion peel extract showed significant larvicidal activity against *Culex* mosquito larvae. The larval mortality increased with increase in concentration and exposure time showing a dose and time dependent effect of the plant extracts. Among the tested extracts, garlic peel extract gave the best result by causing 100% mortality with shortest time, followed by papaya leaf extract and onion peel extract showed moderate activity. Results revealed the presence of bioactive compounds in these plant-based extracts which can effectively control mosquito larvae and can be used as eco-friendly, biodegradable and economically viable alternatives to synthetic insecticides. Therefore, the application of botanical larvicides might have a part in sustainable mosquito vector control and could reduce the environmental hazards associated with chemical insecticides.

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