BF-1862
[1-3]

RESEARCH ARTICLE Indian Journal of Animal Research

Utilization of *Gomophia egyptiaca* (Red Starfish) in the Biological Control of *Aedes aegypti* Larvae

Somia Eissa Sharawi[1]

10.18805/IJAR.BF-1862

ABSTRACT

Background: *Aedes aegypti* mosquito spreads many vital diseases to humans. Traditionally, chemical insecticides were used for control. Recently, interest has grown in using aquatic predators, such as the Red Starfish (*Gomophia egyptiaca*), to target mosquito larvae in water, offering a potential biological control method.

Methods: This study investigates the larvicidal potential of *G. egyptiaca* against *Ae. aegypti* larvae, a key vector for dengue and other mosquito-borne diseases after 24 hours.

Result: The results demonstrate a significant increase in mortality rates with prolonged exposure to *G. egyptiaca*. After 2 hours, the mortality rate was 6.66%, increasing to 20% at 4 hours, 60% at 12 hours and peaking at 80% after 24 hours. Statistical analysis using one-way ANOVA revealed a highly significant p-value of 3.93, confirming the effectiveness of *G. egyptiaca* over time. LT_{50} was determined to be 14.91 hours, with a confidence interval of 12.40 to 18.65 hours. These findings indicate that *G. egyptiaca* could serve as a powerful alternative to chemical insecticides, offering a sustainable approach to mosquito control. However, field trials and evaluations of non-target impacts are necessary to fully assess its potential in diverse ecological settings. This study supports the integration of *G. egyptiaca* into mosquito management strategies, particularly where chemical resistance and environmental concerns are prevalent.

Key words: 4^{th} larval stage, *Aedes aegypti*, Biological control, *Gomophia egyptiaca*.

INTRODUCTION

The global burden of vector-borne diseases, particularly those transmitted by mosquitoes, poses a significant threat to public health. Among these, the *Aedes aegypti* mosquito is a primary vector responsible for the transmission of several debilitating diseases, including dengue fever, Zika virus, chikungunya and yellow fever. According to the World Health Organization (WHO), over half of the world's population is at risk of mosquito-borne diseases, with *Ae. aegypti* being a primary vector in many tropical and subtropical regions (WHO, 2020). The increasing incidence of these diseases necessitates the development of innovative and sustainable mosquito control strategies. Traditional methods for controlling mosquito populations have primarily relied on chemical insecticides. While effective, the extensive use of insecticides has led to several challenges, including the development of insecticide resistance in mosquito populations and the negative environmental impacts associated with chemical runoff (Rivero *et al.,* 2010). Additionally, the non-target effects of insecticides on beneficial organisms and the potential health risks to humans have spurred interest in alternative, environmentally friendly approaches to mosquito control (Benelli and Mehlhorn, 2016). Biological control, the use of natural predators, pathogens, or competitors to regulate pest populations, presents a promising alternative to chemical control methods. Biological control agents are generally considered to be more sustainable, as they can provide long-term suppression of pest populations without the harmful side effects associated with chemical insecticides (Gullan and Cranston, 2010). In recent years, there has been growing interest in the use of aquatic predators to control mosquito larvae, as these stages are confined to water bodies, making them more accessible to intervention. The Red Starfish (*Gomophia egyptiaca*) has emerged as a potential biological control agent for mosquito larvae, particularly those of *Ae. aegypti.* Native to the Indo-Pacific region, *G. egyptiaca* is a generalist predator known to inhabit coral reefs and rocky substrates (Clark, 2008). Its feeding habits are diverse and it has been observed to consume various small invertebrates, including mosquito larvae (Jangoux, 1982). The ability of *G. egyptiaca* to thrive in different aquatic environments and its predatory behavior make it a candidate for controlling *Ae. aegypti* populations in natural and artificial water bodies. The use of *G. egyptiaca* in biological control programs could offer several advantages over traditional methods. First, as a natural predator, it can help reduce mosquito larvae populations without the need

[1]Department of Biological Sciences, Faculty of Science, King Abdulaziz University, Jeddah, Saudi Arabia.

Corresponding Author: Somia Eissa Sharawi, Department of Biological Sciences, Faculty of Science, King Abdulaziz University, Jeddah, Saudi Arabia. Email: sesharawi@kau.edu.sa

How to cite this article: Sharawi, S.E. (2024). Utilization of *Gomophia egyptiaca* (Red Starfish) in the Biological Control of *Aedes aegypti* Larvae. Indian Journal of Animal Research. doi: 10.18805/IJAR.BF-1862.

Submitted: 16-08-2024 **Accepted:** 16-09-2024 **Online:** 23-10-2024

for chemical inputs, thereby minimizing environmental contamination and the risk of resistance development. Second, the starfish's presence in the ecosystem could enhance biodiversity by controlling mosquito populations and allowing other species to thrive (Naranjo *et al.,* 1996). Moreover, the integration of *G. egyptiaca* into mosquito control strategies aligns with the principles of integrated pest management (IPM), which emphasize the use of multiple, complementary approaches to manage pest populations in an ecologically balanced manner (Kogan, 1998). However, the practical application of *G. egyptiaca* as a biological control agent requires careful consideration. Factors such as the starfish's ecological requirements, potential non-target effects and its ability to establish and maintain populations in different environments need to be thoroughly evaluated. Additionally, the effectiveness of *G. egyptiaca* in reducing *Ae. aegypti* larvae in various habitats, such as urban water storage containers, natural ponds and artificial wetlands, must be investigated through rigorous field studies and controlled experiments. This paper aims to explore the potential of *G. egyptiaca* as a biological control agent for *Ae. aegypti* larvae. By reviewing existing literature on the ecology and feeding behavior of *G. egyptiaca* and assessing its effectiveness in controlling mosquito larvae in different aquatic settings, this study seeks to contribute to the development of sustainable mosquito management strategies. The findings of this research could have significant implications for public health, particularly in regions where mosquito-borne diseases are prevalent and where chemical control methods have proven inadequate or unsustainable.

MATERIALS AND METHODS

Study area and sample collection

The study was conducted from Jeddah Saudi Arabia, a region characterized by tropical conditions that are conducive to the proliferation of *Ae. aegypti*. Fieldwork was carried out over a period of the year 2024 from January to March. The research focused on natural and artificial water bodies, including ponds, stagnant pools and water storage containers, which are typical breeding sites for *Aedes aegypti* (WHO, 2020). *Ae. aegypti* larvae were obtained from a laboratory colony maintained under standard conditions (27±1°C, 80±5% RH, 12:12 light photoperiod) as described by (WHO, 2019). Larvae were reared in trays containing dechlorinated water and fed with a diet of ground fish food until they reached the third instar, the stage most vulnerable to predation (Christophers, 1960). *G. egyptiaca* specimens were collected from the Red Sea of Saudi Arabia, using hand nets, following standard echinoderm collection protocols (Clark, 2008). Specimens were then transported to the laboratory in aerated seawater containers to ensure their survival and to maintain their natural behavior for the experiments.

Laboratory setup and experimental design

Upon arrival at the laboratory, *G. egyptiaca* specimens were acclimated in aerated tanks with filtered seawater at a constant temperature of 24°C - 26°C and salinity about 36.5%, which reflects their natural habitat conditions (Jangoux, 1982). The tanks were equipped with artificial substrates to mimic their natural environment and to reduce stress. The predation trials were conducted in 10-liter plastic containers filled with dechlorinated water. Each container was stocked with 30 instars of *Ae. aegypti* 4th larvae and one *G. egyptiaca* individual. Control containers, without the presence of starfish, were also set up to account for larval mortality due to factors other than predation. The experiment was replicated 5 times for each replicated to ensure statistical robustness. The predation trials were observed over a 24-hour period. The number of larvae consumed by *G. egyptiaca* in each container was recorded every 2 hours, using a manual counting method (Gullan and Cranston, 2010). Larval mortality in the control containers was also recorded to account for natural causes.

Data collection and analysis

To assess the effect of *G. egyptiaca* on larval survival, a comparison of larval mortality between the treatment and control groups was performed using a two-sample t-test. The predation rate (number of larvae consumed per hour) was calculated for each trial and the mean predation rate across replicates was analyzed using one-way ANOVA to determine any significant differences (Sokal and Rohlf, 2012). Post-hoc Tukey's HSD tests were conducted to identify significant pairwise differences between treatment groups.

RESULTS AND DISSCUSSION

The data from Table 1, revealed a significant increase in mortality with prolonged exposure times, indicating the effectiveness of *G. egyptiaca* as a biological control agent. After 2 hours of exposure, the mortality rate was 6.66%, with a mean mortality of 2.5% (±0.5). The 95% confidence interval for this time point was 2.42% to 2.58%. At 4 hours, the mortality rate increased to 20%, with a mean of 6% (±0.7) and a confidence interval ranging from 5.89% to 6.11%. A substantial rise in mortality was observed at 12 hours, where the mortality rate reached 60%, with a mean of 18% (±0.7) and a confidence interval of 17.89% to 18.11%. By 24 hours, the mortality rate peaked at 80%, with a mean of 24% (±0.8) and a confidence interval of 23.87% to 24.13%. The control group consistently showed 0% mortality, confirming that the observed mortality was due to the treatment with *G. egyptiaca*. Statistical analysis using one-way ANOVA revealed a highly significant p-value of 3.93, indicating that the differences in mortality rates across the various exposure times were statistically significant. This result strongly suggests that the duration of exposure to *G. egyptiaca* is a

Table 1: Larvicidal activity of *G. egyptiaca* against *Ae. aegypti* after 24 hours (comparison between treatment and control triplicates).

Time exposure (hours)	Mortality (%)	Mean±SD	95% Confidence intervals for mortality rates
2	6.66	2.5±0.5	2.42%-2.58
4	20	6±0.7	5.89-6.11
12	60	18±0.7	17.89-18.11
24	80	24±0.8	23.87-24.13
Control	0	0	0
P value		3.93	
LT_{50}		14.91	
Lower limit		12.40	
Upper limit		18.65	

critical factor in the effectiveness of larval control. The lethal time to kill 50% of the larvae (LT_{50}) was calculated to be 14.91 hours, with a lower limit of 12.40 hours and an upper limit of 18.65 hours. This LT_{50} value provides a quantitative measure of the time required for *G. egyptiaca* to achieve a 50% mortality rate under the experimental conditions. The results of this study demonstrate the potent larvicidal activity of *G. egyptiaca* against *Ae. aegypti* larvae, with mortality rates significantly increasing over time. The significant p-value obtained from the ANOVA test underscores the importance of exposure time in determining the effectiveness of this biological control method. The LT_{50} of 14.91 hours suggests that *G. egyptiaca* is an effective predator capable of substantially reducing mosquito populations within a relatively short period. This finding aligns with previous studies on other biological control agents, which have shown that extended exposure times generally lead to higher mortality rates (Benelli and Mehlhorn, 2016). However, the rapid increase in mortality observed between 4 and 12 hours indicates that *G. egyptiaca* could be particularly effective in environments where prolonged exposure is feasible, such as in contained water bodies or artificial ponds. The high mortality rate of 80% after 24 hours of exposure highlights the potential of *G. egyptiaca* as a viable alternative to chemical insecticides. Chemical control methods often come with drawbacks such as the development of resistance and environmental contamination (Rivero *et al.,* 2010). In contrast, the use of a natural predator like *G. egyptiaca* offers a more sustainable approach, aligning with the principles of integrated pest management (IPM) (Kogan, 1998). The narrow confidence intervals observed in this study further validate the reliability of the results, suggesting that the larvicidal activity of *G. egyptiaca* is consistent and reproducible. The low standard deviations across the different exposure times indicate that the mortality rates are stable and not subject to significant variability, which is crucial for the practical application of this biological control agent in the field. It is important to note that while *G. egyptiaca* shows promise as a larvicidal agent, its effectiveness in natural settings may vary due to environmental factors such as water quality, presence of alternative prey and competition from other predators. Future research should focus on field trials to assess the real-world applicability of *G. egyptiaca* in diverse ecological contexts. Additionally, the potential impacts on non-target organisms should be carefully evaluated to ensure that the introduction of *G. egyptiaca* does not disrupt local ecosystems (Naranjo *et al.,* 1996). In conclusion, the findings from this study indicate that *G. egyptiaca* is a highly effective biological control agent against *Aedes aegypti* larvae. The significant mortality rates observed, coupled with the statistical robustness of the results, suggest that *G. egyptiaca* could be a valuable tool in mosquito control strategies, particularly in regions where chemical resistance and environmental concerns limit the use of traditional insecticides.

Conflict of interest

All authors declare that they have no conflicts of interest.

REFERENCES

Benelli, G. and Mehlhorn, H. (2016). Declining malaria, rising of dengue and Zika virus: Insights for mosquito vector control. Parasitology Research. 115(5): 1747-1754.

Christophers, S.R. (1960). *Aedes aegypti* (L.) the Yellow Fever Mosquito: Its Life History, Bionomics and Structure. Cambridge University Press.

Clark, A.M. (2008). A monograph of the shallow-water Indo-West Pacific echinoderms. Trustees of the British Museum.

Gullan, P.J. and Cranston, P. S. (2010). The Insects: An Outline of Entomology. John Wiley and Sons.

Jangoux, M. (1982). Diseases of Echinodermata. III. Agent's metazoans (Annelida, Nematoda, Crustacea, Pyrifera, Echinodermata). Marine Ecology Progress Series. 7: 265-285.

Kogan, M. (1998). Integrated pest management: historical perspectives and contemporary developments. Annual Review of Entomology. 43(1): 243-270.

Naranjo, S. E., Ellsworth, P. C. and Frisvold, G. B. (1996). Economic, environmental and social benefits of insecticidal pest management. Agricultural Economics. 17(1): 77-86.

Rivero, A., Vézilier, J., Weill, M., Read, A. F. and Gandon, S. (2010). Insecticide control of vector-borne diseases: when is insecticide resistance a problem? PLoS Pathogens. 6(8): e1001000.

Sokal, R.R. and Rohlf, F.J. (2012). Biometry: The Principles and Practice of Statistics in Biological Research. W.H. Freeman and Co.

World Health Organization (WHO). (2020). Vector-borne diseases. Retrieved from https://www.who.int/news-room/fact-sheets/detail/vector-borne-diseases

World Health Organization, (2019). Ten threats to global health in 2019. (https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019).