MOSQBLOCK CONCOGTION:

An Environmentally Safe Mosquito Larvae Control Block

for Use in Drainage and Open Water Channels

Research By:

Jophiel Philanna Deusvult

(Sekolah Bintang Mayantara)

2025

Table of Contents

CHAPTER I

ABSTRACT

Malaria remains a critical global public health challenge, with an estimated 282 million cases and approximately 600,000 deaths worldwide in 2024, primarily driven by Anopheles mosquitoes that breed in stagnant open drainage systems commonly found in tropical regions. This study presents *MosqBlock Concogtion*, a low-cost and environmentally conscious mosquito larvae control system designed for use in open drainage channels. The system integrates *Bacillus thuringiensis* var. *israelensis* (Bti), delivered via Mosquito Dunks®, with a dual-layer filtration mechanism consisting of 0.5 µm cartridge filters and biodegradable coconut mesh. This filtration system is intended to limit the unintended dispersal of Bti into connected natural water bodies, thereby reducing potential ecological risks to non-target aquatic organisms. Prototype testing demonstrated that mosquito larvae in the treated section of the drainage system were eliminated within five days, while larvae remained present beyond the filtration barrier, indicating effective containment of the larvicide. Additionally, a reduction in adult mosquito presence was observed following treatment. The total cost of the essential components of MosqBlock Concogtion was approximately USD 23.49, suggesting that this system may offer a practical, affordable, and environmentally responsible solution for mosquito control in resource-limited tropical environments.

CHAPTER II

INTRODUCTION

According to the World Health Organization (WHO, 2025), an estimated 282 million malaria cases were reported globally in 2024. Untreated malaria infections can result in severe health complications, including anemia, neurological damage, organ failure, respiratory distress, and ultimately death (Kementerian Kesehatan Republik Indonesia, 2024). These complications accounted for approximately 600,000 deaths worldwide in the same year (WHO, 2025). This persistent global burden highlights the urgent need for effective, accessible, and sustainable mosquito control strategies.

Living in a tropical region where malaria-transmitting Anopheles mosquitoes are prevalent, the author identified unmaintained open drainage systems as a critical local contributor to mosquito breeding (Mokuolu et. al., 2018). These drainages frequently contain stagnant water, organic debris, and limited flow, creating optimal conditions for larval development. Motivated by these observations, this study aims to develop a mosquito control solution that is both economically feasible and environmentally responsible, with a particular focus on minimizing negative impacts on connected natural aquatic ecosystems.

CHAPTER III

MATERIALS AND METHODS

1. Larvicide

1.1 Mosquito Dunks®

An initial review of commercially available mosquito control products led to the selection of Mosquito Dunks®, manufactured by Summit® Chemical Co. Mosquito Dunks® are designed to release a biological larvicide into water bodies, specifically targeting mosquito larvae. Each dunk is capable of treating up to 100 square feet of water surface area for approximately 30 days, regardless of water depth (Summit Responsible Solutions (n.d.)). Once placed in water, the active agent gradually disperses and settles near the bottom, where mosquito larvae ingest it, leading to mortality (Ramey, 2008).

1.2 *Bacillus thuringiensis* var. *Israelensis*

The active component of Mosquito Dunks® is *Bacillus thuringiensis* var. *israelensis* (Bti) (Summit Responsible Solutions, n.d.), a bacterium that produces crystalline toxins lethal to mosquito larvae upon ingestion. The City of Grand Prairie (n.d.) explains that these toxins are activated in the alkaline environment of the mosquito larval gut, causing gut rupture and subsequent death. However, existing literature presents mixed findings regarding the effects of Bti on non-target aquatic organisms, particularly chironomids.

Boisvert and Boisvert (2016) reported no detectable short- or long-term impacts on non-target aquatic invertebrate communities in wetland environments. In contrast, Lacey (1989) identified toxicity effects on several nuisance fly species. More recently, van Nieuwpoort et al. (2025) cautioned that excessive or repeated Bti application may significantly reduce chironomid populations, which serve as a foundational component of freshwater food webs. Brühl and

Bakanov (2020) further emphasized that reductions in mosquito and midge populations could indirectly affect higher trophic levels. These findings informed the decision to incorporate a filtration mechanism to limit unintended bacterial dispersal.

2. Filter

Given that open drainage systems often connect directly to natural water bodies, a filtration system was designed to confine Bti-treated water to the targeted area while maintaining larvicidal effectiveness.

2.1 Cartridge Filter

Bacillus thuringiensis is a Gram-positive, spore-forming bacterium measuring approximately 0.5–1.0 × 2–5 µm in size (ScienceDirect, n.d.). Based on these dimensions, a minimum pore size of 0.5 µm was selected for effective filtration. Commercially available 0.5 µm cartridge filters were chosen due to their affordability (approximately USD 1.50 per unit), accessibility, and common use in household water filtration systems.

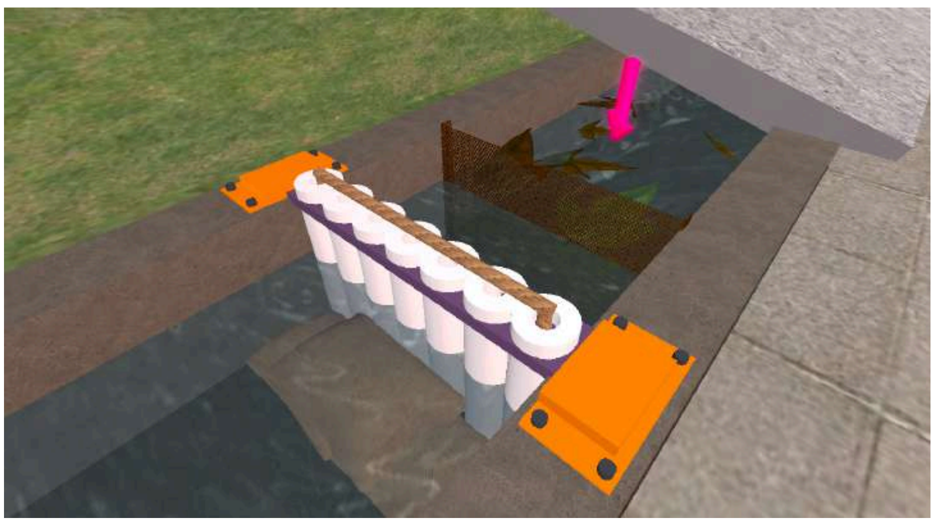
2.2 Coconut Mesh

To prevent physical damage and clogging of the cartridge filters caused by large debris such as fallen leaves, an additional pre-filtration layer was incorporated. Woven coconut mesh, also known as coir geotextile, was selected for this purpose. According to The Harvest Co. (2025), coir geotextiles are biodegradable, sustainable, and environmentally friendly, making them suitable for long-term outdoor applications.

3. Prototype

3.1 Metaverse Prototype

A digital prototype was constructed using the Firestorm sandbox building application to visualize the system's structure and deployment. In this model, cartridge filters were aligned horizontally, secured together with rope, and mounted onto a plastic support to form a barrier across the drainage channel. Sandbags were placed downstream to stabilize the structure against water flow, while coconut mesh was attached to the drainage walls to intercept large debris.



Picture 1. Initial prototype for MosqBlock Concogtion, built in Firestorm, containing a simulation of a drainage and leaves falling.

3.2 Real-Life Prototype

A small-scale physical prototype was constructed to test the proposed system. Materials included eight 0.5 µm cartridge filters, coconut mesh, PVC pipes, and one Mosquito Dunk®. An artificial drainage system was created using two tarp pond liners connected by an opening and supported by steel rods. Water was added to simulate stagnant drainage conditions.

Picture 2. Real-life prototype of MosqBlock Concogtion placed in an imitation drainage, with dry leaves to imitate fallen debris.

The cartridge filters were connected using PVC piping inserted through the pre-existing filter holes and secured into a larger pipe drilled with evenly spaced, pipe-sized holes, forming a flute-like configuration to ensure structural stability. The entire assembly was tied to the steel frame using plastic string. Coconut mesh was suspended upstream to intercept debris. A mosquito trap constructed from cardboard, CPU fans, mesh fabric, and a UV light was placed nearby to monitor adult mosquito populations.

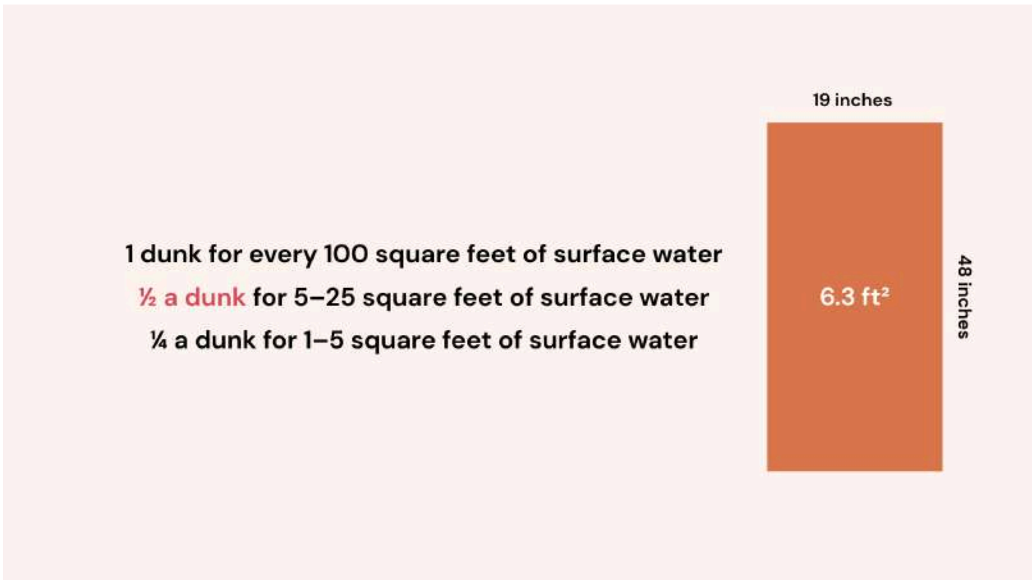
Picture 3. Mosquito trap placed in a dark spot, under a table, to attract mosquitoes and keep track of them.

Larvae were observed developing within several days. After a one-week maturation period, baseline mosquito trap data were collected for five days. Subsequently, half of a Mosquito Dunk® was added in accordance with manufacturer dosage guidelines for the 6.3 square foot surface area. Observations continued for an additional five days.

Picture 4. Many larvae spotted days after the making of the imitation drain, and leaves turned transparent indicating the larvae have been feeding on them.

Picture 5. After a week, the author turned on the mosquito trap, and waited for 5 days. On the 5th day, the author opened the mosquito trap to check how many it had trapped. Upon opening it, the author counted 5 live mosquitoes that flew out, and 18 dead mosquitoes.

Subsequently, half of a Mosquito Dunk® was introduced in accordance with the manufacturer's dosage guidelines, which recommend one-quarter of a dunk for water surfaces of 1–5 square feet, one-half of a dunk for 5–25 square feet, one dunk for 25–100 square feet, and one dunk per 100 square feet for areas exceeding 100 square feet (Summit Chemical Co., n.d., p. 2). This dosage was selected based on the surface area of the imitation drainage system, which measured 6.3 square feet.



Picture 6. Illustration for the area size of the imitation drainage.

Picture 7. Half of a Mosquito Dunk® being applied to the drainage system

Picture 8. Half of the Mosquito Dunk® settles in the imitation drainage system shortly after application

Following the application of Mosquito Dunks®, observations were continued for an additional five days. No live mosquito larvae were detected in the treated section of the drainage system, whereas a small number of live larvae remained present in the untreated section downstream of the cartridge filters.

Picture 9. No larvae were spotted 5 days after on the section where the dunks were put.

Regarding the mosquito trap, two live adult mosquitoes were observed escaping upon inspection, while ten dead specimens were recorded.

Picture 10. 10 dead mosquitoes trapped 5 days after treatment.

CHAPTER IV

RESULTS AND DISCUSSION

The results indicate that MosqBlock Concogtion effectively reduced mosquito larvae and adult mosquito presence within the treated drainage system. Prior to treatment, numerous larvae were observed feeding on organic debris, and the mosquito trap recorded 5 live and 18 dead adult mosquitoes over a five-day period. Five days after introducing half a Mosquito Dunk®, no live larvae were observed in the treated section, while larvae remained present in the water beyond the filtration barrier, demonstrating effective containment.

Post-treatment mosquito trap data showed a reduction to 2 live and 10 dead mosquitoes. Cost analysis revealed that the total estimated cost of the system was approximately USD 23.49, covering Mosquito Dunks®, cartridge filters, coconut mesh, and sandbags, with an estimated operational duration of four months.

Limitations of the study include the short observation period, small-scale testing, and the absence of flow-rate modeling. Future studies should evaluate long-term ecological impacts, durability under continuous flow conditions, and maintenance requirements in real drainage environments.

CHAPTER V

CONCLUSION

MosqBlock Concogtion represents a practical, low-cost, and environmentally responsible approach to mosquito larvae control in stagnant open drainage systems. By combining Bti-based larvicides with a dual-layer filtration system, the design effectively eliminates mosquito larvae while limiting the unintended spread of Bti into connected natural water bodies. This approach addresses ecological concerns related to non-target species that play critical roles in aquatic and terrestrial food webs.

With minimal material costs and flexible implementation options, MosqBlock Concogtion is well-suited for resource-limited tropical regions. The use of biodegradable materials and adaptable construction methods further supports its sustainability and ease of maintenance.

CHAPTER VI

ACKNOWLEDGEMENTS

The author gratefully acknowledges the support of educators, peers, and referenced institutions whose research and resources contributed to the development of this study.

REFERENCES

World Health Organization. (n.d.). *Malaria data* [Data theme]. WHO. https://www.who.int/data/gho/data/themes/malaria

Kementerian Kesehatan Republik Indonesia. (2024, May 16). *Kenali apa itu malaria: gejala, pencegahan, dan pengobatan*. Ayo Sehat. https://ayosehat.kemkes.go.id/apa-itu-malaria

U.S. National Library of Medicine. (n.d.). *Malaria* in *Disease Reference Overview*. In *NCBI Bookshelf*. https://www.ncbi.nlm.nih.gov/books/NBK215619/

Mokuolu, O. A., Coker, A. O., Adejumo, M., & Sridhar, M. K. C. (2018). Modeling a covered drainage system for the reduction of malaria prevalence. *Ain Shams Engineering Journal, 9*(4), 1647–1651. https://doi.org/10.1016/j.asej.2016.07.009 Directory of Open Access Journals

Summit Responsible Solutions. (n.d.). *Mosquito Dunks®*. Summit Chemical. https://summitchemical.com/products/mosquito-dunks/

Author Unknown. (n.d.). *Mosquito Dunk danger: Are they safe?* TheHorse.com. https://thehorse.com/122961/mosquito-dunk-danger/

City of Grand Prairie. (n.d.). *Larvicides information* [PDF]. Public Health & Environmental Quality.
https://www.gptx.org/files/sharedassets/public/v/2/departments/public-health-amp-environmental-quality/documents/larvicides-information.pdf

Author Unknown. (2016). Title unknown. *Science of the Total Environment, Volume* ——. https://doi.org/10.1016/j.scitotenv.2016.02.096
(Catatan: Judul aslinya bisa dimasukkan setelah buka link jurnal.)

Lacey, L. A. (1989). Some effects of *Bacillus thuringiensis* var. *israelensis* on non-target organisms. *Water Research*, *23*(10), pages unknown. https://doi.org/10.1016/0043-1354(89)90104-8

Author Unknown. (2025). Title unknown. *Parasites & Vectors*, *Volume*, pages unknown. https://doi.org/10.1186/s13071-025-06907-8

Author Unknown. (2020). Title unknown. *Science of the Total Environment, Volume ——*. https://doi.org/10.1016/j.scitotenv.2020.137800

Savini, V., & Fazii, P. (2016). *Bacillus thuringiensis insecticide properties.* In *The Diverse Faces of Bacillus cereus* (pp. 139–155). Academic Press/Elsevier. https://doi.org/10.1016/B978-0-12-801474-5.00012-8 ScienceDirect+1

Indonesia Cocopeat. (n.d.). *Coir geotextile*. Indonesia Cocopeat. https://indonesiacocopeat.com/coir-geotextile/

Summit Responsible Solutions. (2021). *Mosquito Dunks® specimen* [PDF]. Summit Chemical. https://summitchemical.com/wp-content/uploads/2021/01/102-12-SPECIMEN_DUNKS.pdf