

Original Article

Short report: unmanned aerial vehicle for wide area larvicide spraying (WALS) using Vectobac® WG at Kota Kinabalu, Sabah

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Abstract

Introduction: Given the stagnating progress in the fight against dengue in Kota Kinabalu, there is an urgent need to use other strategies to complement the existing vector control, focusing on larviciding. Unmanned aerial vehicle (UAV) technology has been used in vector control programs in many countries. The aim of this study was to determine the feasibility of using UAVs for larviciding to control *Aedes* mosquitoes in urban areas.

Methodology: The Hexarotor Agro Drone (Polardrone Sdn Bhd, Malaysia) was used to carry out larviciding using Vectobac® manufactured by Valent BioSciences LLC, Libertyville, USA. The drone flew at a height of 10 feet and at a speed of 5 m/s. A total of 32 items with 10 larvae in each item were placed to test the effectiveness of larviciding using UAV.

Results: Out of 32 items used, 4 containers had a 100% larva mortality (13.3% mortality). The drone was not able to reach the designated spraying route that had been pre-programmed. This was due to interference with the electromagnetic waves emitted from the home satellite dishes, that were in front of the houses along the route.

Conclusions: This trial showed that UAVs will be more suitable for use in larviciding in an open area without electromagnetic disturbances from electric house poles and satellite TV dishes that are commonly present in urban areas.

Key words: dengue; larvicide; unmanned aerial vehicle (UAV).

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Introduction

A challenge in controlling dengue is the difficulty in eliminating the breeding points, especially in urban areas. In urban areas, mosquito larvae habitats are often in complex and challenging locations such as empty flower pots, buckets, discarded tires and areas where trash accumulates [1]. These areas may include peri or intra-domestic environments. In most circumstances, these locations are difficult to access or even inaccessible when they are in private properties where vector control personnel cannot reach [2,3]. Moreover, these habitats are in cryptic locations and are often factors obstructing elimination of mosquito breeding points. Backpack sprayers using mist-blowers to spread the larvicide are unable to cover large areas of breeding points.

In 2022, there was a drastic rise in dengue incidence in the city of Kota Kinabalu. There was a 267% increase in dengue cases in 2022 compared to 2021. A total of 94 localities were involved in the 2022 dengue outbreak. Of those 94, a total of 27 localities showed repeated outbreaks in the same year. Dengue cases were

reported in a variety of localities including illegally occupied residences (i.e., squatters) and well-planned residential areas in Kota Kinabalu. These localities also had repeated outbreaks of dengue within the same year.

Controlling dengue is difficult; new and improved methods and techniques must complement the traditional control programs. The unmanned aerial vehicle (UAV) technology was originally developed for performing dull, dirty, or dangerous missions for the military [4]. However, today, this technology is used in many other fields including scientific studies, commercial activities, recreational use, and agricultural applications. UAVs have also been revolutionary in vector control [4].

UAV applications of ultra-low volume (ULV) adulticide and granular and liquid larvicides are currently being tested in a few countries [5,6]. The current control strategies against dengue in Kota Kinabalu may have reached a plateau point. There is an urgent need for area-wide integrated vector management strategies to control dengue. These include complementing and enhancing existing

methods and tools of dengue combat such as home visits, fogging and spotting larvicide. New technology adoption is imperative to increase the efficiency and scale of vector management. The aim of this study was to determine the feasibility of employing UAVs to supplement current dengue control efforts, particularly for larviciding in hard-to-access areas. This was needed to establish the practicability of utilizing UAVs in urban settings for larviciding purposes, and for potentially improving the larviciding policy in the public health sector.

Methodology

The trial was conducted at the Kepayan low-cost housing area, which was a hotspot for dengue outbreaks. The outbreaks lasted from November 29, 2022, to February 20, 2023 (a total of 83 days). The UAV trial was conducted on March 17, 2023. The area of focus was Bunga Patuma Lane 9 (a lane between two frequent outbreak areas). The police quarters and Kepayan low-cost housing were located in this area (Figure 1). The storm drain between the police quarters and a row of houses on Bunga Patuma Lane 9 was

Figure 1. Yellow arrow showing Bunga Patuma Lane 9. Larviciding was to be carried out along the yellow line.



inaccessible by foot. It was impossible to ascertain breeding sources in this area.

A total of 32 items were placed along Bunga Patuma Lane 9 to test the effectiveness of larviciding using UAVs. Ten larvae were added to each of 30 plastic containers, 1 old tire and 1 bucket and placed in front of the houses and an alleyway between two houses on Bunga Patuma Lane 9. A total of 320 larvae were used in this trial. Imaging of the lane was done using a small drone. The procedure was carried out as a pilot run by a certified aviation company (NK Robotics Sdn Bhd, Sabah, Malaysia). This company was certified and had been licensed by the Civil Aviation Authority of Malaysia (CAAM) drone pilots. Prior to the trial, permissions were obtained from the Lands and Surveys Department and State Home Affairs and Research Office, Chief Minister's Department and the CAAM. These approval letters were then sent to the Head of Community Development of the Kepayan zone.

The Hexarotor Agro Drone (Polardrone Sdn Bhd, Malaysia) was used for spraying larvicide. This drone had four centrifugal nozzle sprays which could spray with a consistent and even spraying output of 3.5 L/min. The drone was set to fly at a height of 10 feet and at a speed of 5 m/s. The drone was also equipped with an automatic obstacle avoidance sensor to allow it to fly over an obstacle. Vectobac® WG (Valent BioSciences LLC, Libertyville, USA) was the larvicide used for this trial. Vectobac® WG contains *Bacillus thuringiensis israelensis* (Bti). Bti is Environmental Protection Agency (EPA)-registered for use in residential, commercial, and agricultural settings. Bti could be applied safely to mosquito habitats without any detrimental impact on food crops or water supplies. Bti is used in Malaysia as a larvicide in dengue vector control management. There had been no documented resistance to using Bti as a larvicide. Vectobac® WG was obtained in the form of sand granules and mixed with water with a ratio of 125 g in 10 L for spraying. One bottle of Vectobac® WG (250g) was mixed with 20 L of water. The drone's payload was up to 25 L of the larvicide.

Results

All the containers were collected and analyzed for 24-hour larvae mortality percentage. Of the 32 containers used, 4 had 100% larvae mortality (13.3% mortality). The old tire had 4 dead larvae and 6 were still alive (40% mortality), and the bucket had 7 dead larvae and 3 were still alive (70% mortality). The remaining 26 containers still had live larvae in them. Imaging and video recordings were done to map out the

surroundings between the police quarters and Bunga Patuma Lane 9. The image showed dense vegetation in between these two localities (Figure 2).

Unfortunately, the drone was not able to reach the designated spraying route along Bunga Patuma Lane 9 (in front of the houses) as had been pre-programmed. This was due to interference from the electromagnetic waves from the home satellite dishes that were placed in front of the houses along the route. Due to this interference, the drone could not fly in front of the houses and only flew above the roofs of the houses while spraying. The route was then re-programmed to focus only on flying in the alleyway with the drainage system located between two houses that were on Bunga Patuma Lane 9 (Figure 3).

The 4 containers that had 100% larvae mortality were located in the alleyway between the houses and had received 100% coverage by the drone during the larvicide spraying. The remaining containers that were in front of the houses, on Bunga Patuma Lane 9 were not properly covered by the drone's spraying radius due to the aforementioned interference. The tire and the pail were placed in front of the houses and the drone could not spray directly due to interference from the satellite present in the houses next to them. A total of 6 L of the Vectobac® mixture was used in this trial.

Discussion

Studies have shown that UAVs can be effectively used for larviciding and vector control [4,7–9]. UAVs have advantages over traditional larviciding methods for maximum larval control. These advantages include precise larvicide spraying [6]. In addition, the areas that are inaccessible to manned equipment can be accessed and sprayed. Moreover, UAV usage reduces exposure of personnel to hazardous chemicals and landscapes [6]. Maintenance of the UAV after larviciding is also simpler compared to traditional mist blowers and backpacks. No mud or debris deposits on the UAV.

Nevertheless, this study has shown that certain aspects should be taken into consideration when using UAVs in an urban area. These considerations include the presence of satellite dishes, electric poles, and other high-rise structures. Electromagnetic disturbances from electric house poles and satellite TV dishes (ASTRO®, Malaysian Satellite Television, Malaysia) in the drone operation area need to be evaluated when using UAVs for larviciding. Since the pilot activated the automatic obstacle avoidance sensors and flew the drone in an automatic mode by mapping out the complete flight paths, the drone could not reach the mapped area due to the presence of satellite dishes, electric poles, and other

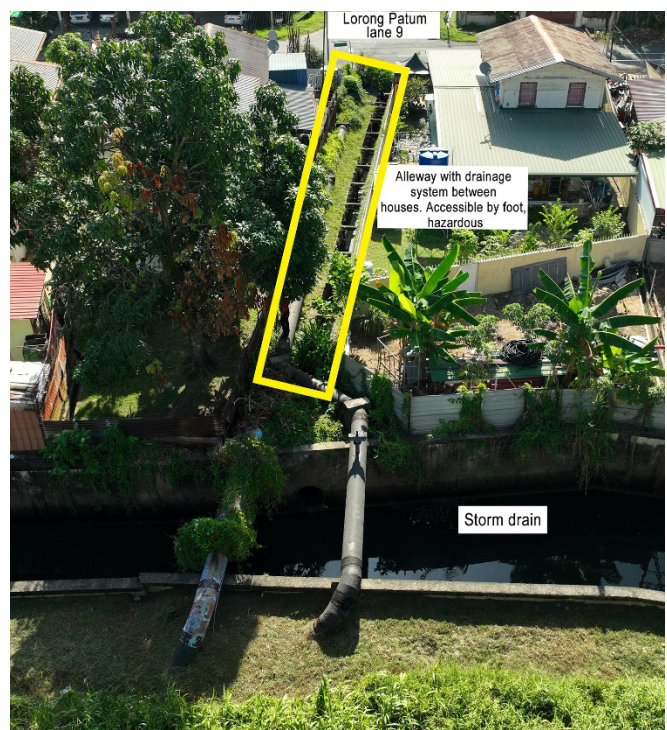
Figure 2. An image was taken using a drone showing dense vegetation in between two localities.



high-rise structures. Using automatic mode is only recommended to be used in large unobstructed places that have no tall structures and other sorts of interferences. This is why it is widely used in agriculture [10,11] and in malaria-affected swamp areas [8,12] for spraying insecticides. However, further study should be carried out to find the actual effectiveness of the use of drones in larviciding for dengue vector by using a manual mode to fly the drone to reach the containers with larvae.

The drone could be used to spray an area of dense vegetation that existed in between the localities which was inaccessible by foot. However, the effectiveness of the larvicide could not be determined immediately because it was impossible to place the larval bioassay in an area of dense vegetation during the study.

Figure 3. Unmanned aerial vehicle (UAV) was reprogrammed to spray in the rectangle area.



Nevertheless, we can see the effectiveness by assessing the frequency of outbreaks in both localities after frequent larviciding in the area. The benefits of UAV in larviciding for vector control still outweigh its limitations, since we were able to larvicide the areas that were not accessible by foot. Unfortunately, renting drone services for larviciding involves a cost. So, further study on the testing of drones for larviciding will be conducted with financial support from the Ministry of Health, Malaysia.

Conclusions

It is important to see the feasibility of the use of new vector control technologies based on the challenges that exist in the localities of dengue outbreaks. Further studies should be conducted by using manual flying mode instead of automatic mode flight paths to see the practicability of UAVs in larviciding for dengue vector control.

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