Development and Testing of a Mosquito Attracting, Trapping and Eliminating Device

IZABO ABIGO
Department of Mechanical &Mechatronic Engineering, Federal University Otuoke, Nigeria

Abstract- Tackling and getting rid of mosquitoes is quite a tough task especially when you don't have access to expensive commercial machines. Even the marketed sprays & medicines are toxic chemicals and very harmful to health. To solve this problem, an advanced mosquito and insect killer was designed. This mosquito killer machine attracts mosquitoes due to ultraviolet light, temperature sensing and other means, kills them instantly as its metal grid emit high voltage electricity. This mosquito insect killer uses a mosquito high voltage grill to kill mosquitoes, thus making it safe for adults to use and also children under supervision. This project is designed to apply a variety of electronic technologies to current light trap models of mosquito traps to improve their utility and ease of use and their potential to generate valuable, timely data for public health.

I. INTRODUCTION

Generally, Mosquitoes are capable of carrying deadly diseases, such as malaria, and transmitting those diseases to humans. This transmission has been a major health issue throughout the world; an estimated 300 million people are infected by malaria each year and over 3 million of these individuals die. There are over 3,000 existing species of mosquitoes in the world today, but only a fraction of these are capable of spreading disease. In an effort to control the mosquito's spread of disease, entomologists make use of mosquito traps, which allows them to monitor the populations of various species of mosquitoes Using the data received from the traps, entomologists are able to make accurate and informed decisions regarding mosquito control. Current Traps In an effort to receive the best data, entomologists make use of two popular kinds of mosquito traps, the gravid trap and the light trap. The light trap attracts mosquitoes using carbon dioxide and light, while the gravid trap attracts mosquitoes using swamp water. The different methods of attraction found within the traps are used to attract different species of mosquitoes. In the light trap, the carbon dioxide is emitted from a canister which is filled with dry ice, and the light is emitted from an incandescent light bulb while In the gravid trap, the swamp water rests in a pan. Aside from their method of attracting mosquitoes, the gravid trap and the light trap are essentially identical. Once mosquitoes are attracted to a certain point, there is a plastic tube which has a fan inside

of it. The fan is turned on when the trap is in use, and mosquitoes are sucked through it and pushed through the cylinder and into a bag, where they stay. The bag's only entrance is through the cylinder, and the fan is powerful enough to keep the mosquitoes from flying out. In order to keep larger bugs out of the traps, there is a mesh filter which is large enough to let mosquitoes pass through but stops the larger bugs. These traps are powered by a standard 6V battery, which typically holds enough power to run for one night. To use the traps, entomologists place them in a designated area late in the evening, where they run for the duration of the night. They then come and collect the traps in the morning, and proceed to hand count how many mosquitoes they collected. The entomologists then speciate each individual mosquito under a microscope, based on their scaling patterns on the abdomen and striping patterns on the legs. This allows the entomologists to receive the data that they need to make informed decisions. Mosquitoes are small, midge-like flies that constitute the family Culicidae. The word "mosquito" (formed by mosco and diminutive -ito) is Spanish for "little fly". Mosquito repellents are substances that are designed to make surfaces unpleasant or unattractive to mosquitoes. They typically contain an active ingredient that repels mosquitos as well as secondary ingredients, which aid in delivery and

cosmetic appeal. Different mosquito repellents work in different ways. While most of them do not kill mosquitoes and just help repel them, others kill them. How long repellents stay effective depends on the nature of the ingredients and the concentration of the ingredients. There are several kinds of repellents. Repellents could be Chemical, Spatial, Natural repellents and Gadgets. These repellents have proven to be less effective in this modern times and the need for technology advanced machines to help in the drastic reduction of these flying insects has become very necessary.

To kill these flying insects, they should first be attracted and then electrocuted. An electric fly swatter is one such device with a high voltage electrocuting circuit and an insect attracting UV lamp of 365 nm wavelength.

Insects bite is one of the major causes of sickness and diseases to human beings. Insect such as mosquito and tsetse fly are the cause of malaria and sleeping sickness according to world health organization (WHO). In the last decade people use different methods of controlling insect – mosquito, such methods are the use of mosquito net, mosquito coil, and herbs. However, these methods of controlling and killing of mosquitoes are not fully effective due to some limitations attached to them. In this work, we are designing an electronics means of killing mosquito insect. In this method, a high voltage electrocuting circuit and an insect attracting UV lamp, heating metal rods, was used. It has uv lights that attract bugs to it and an electric mesh that kills the mosquitoes after being sucked into the machine by the suction fan, which grabs and kill the mosquitoes. The UV lights attract insects towards the lamp and the high voltage grill will kill all the insects that approaches the light and gets trapped in the machine (Abigo et al 2012).

II. LITERATURE REVIEW

- *Definition of mosquito repellent*

A mosquito repellent is a substance applied to skin, clothing, or other surfaces which discourages insects (and arthropods in general) from landing or climbing on that surface. There is also mosquito repellent products available based on sound production, particularly ultrasound (inaudibly high frequency sounds). (Patel et al,(2012).

- *Methods of Mosquito Control*

According to Patel et al (2012), it was asserted that specialty products like mosquito repellent used to combat mosquitoes are required. Different products used for mosquito control have varying degrees of effectiveness. Afeefa et al (2019) stated that Mosquitoes represent the major vectors involved in the spread of deadly diseases like Malaria, Lymphatic filariasis, Chikungunya and arboviruses like dengue virus and Zika virus. These diseases have emerged with the rise of urbanization and the use of chemical insecticides around the world.As stated by Sana naseem et al (2016),For many viral, bacterial and protozoans' diseases mosquitoes act as vector. In terms of disease transmission and public health importance mosquito are considered as very important group of insects. Population of mosquito's increases exponentially that is major problem for many countries. Pesticides have a role in public health as part of sustainable integrated mosquito management. Other components of such management include surveillance, source reduction or prevention, biological control, repellents, traps, and pesticide-resistance management.(Robert I. Rose,(2001). According to batool, k et al (2018), Mosquito control programs are faced with significant and rapidly changing challenges that necessitate the development of new approaches in the detection and control of diseases as a new requirement in public health. Biocontrol strategies aim to be sustainable and target a range of different mosquito species to reduce the current reliance on insecticide-based mosquito control.(Giovanni benelli et al,(2016). Braack et al, (2015) reported on the biting behaviour of African malaria vectors to identify where they tend to bite on the human body. The vectors used in the study were Anopheles arabiensis from Malahlapanga in South Africa, and Anopheles gambiae and Anopheles funestus from northern Uganda. The results showed that more than 93 % of mosquito bites occur on the ankles and feet of people seated or standing outdoors. Additionally, the study reported that mosquitoes are attracted to the smell of the feet and ankles. However, if the feet and ankles are protected or covered, the mosquitoes will not bite above the ankle but seek alternative hosts with non-covered ankles and feet.

As stated by Mang're, (2012) Insecticides are substances or a mixture of substances used for destroying, preventing, repelling or mitigating insects. They are commonly used due to their ease of application, fastacting, and effectiveness against wide variety of insect. However, there is no report or documentation which specifically refers to the use of insecticide against insect's control which doesn't have potential hazard to man and the eco-system in general.Li C-X et al, (2016), Rasmussen E. (2020) research shows that UAVs(unmanned aerial vehicles) can be used as a means of delivering vector control interventions to a target site (larvicides, insecticides, or mosquitoes modified to disrupt the vector population).As asserted by Fillinger U, lindsay SW. (2011) the abundance and distribution of malaria transmitting mosquitoes is dependent on the availability of water bodies to act as breeding sites. For mosquitoes breeding sites to be targeted effectively in disease control programmes, up-to-date information on their locations must be collected.

- *Classification of mosquito repellents*

Mosquitoes vector numerous diseases including malaria, dengue, west nile virus and yellowfever. Even in the absence of disease, mosquitoes are an annoyance that can disrupt outdoor activities at night. The use of repellents decreases contacts between mosquitoes and their hosts, and may even lower the rate of disease transmission in many instances.

(J.C. Dickens, J.D. Bohbot(2013).

Classification of mosquito repellent includes the following:

1. Chemical methods: Chemical method involves the use of Synthetic repellents, example; DEET, and natural repellents example; Neem oil, citronella oil.
2. Nonchemical methods: This method involves a more physical and mechanical approaches.
3. Physical methods: Medicated Net, Non medicated net, Mosquito trap
4. Mechanical methods: Electric mosquito zapper, Mosquito magnet
5. Biological methods: This methods involves the use of biological animals, for example; some species of fish to feed on mosquito larvae in controlled water bodies.

- *Electronic Mosquito Repelling Devices (EMR)*

Electronic mosquito repellent devices are devices that aid the removal and reduction of mosquitoes from the environment.Ibrahim A.G et al, (2013) stated that the use of Electronic Pest Control Devices has been bedeviled by lots of controversies bothering on their effectiveness. The arguments are that they are ineffective, partially effective or very effective.

Ayankumar et al, (2014) describes a novel mosquito trapping system by employing the advantage of fibre optic sensor and provides the efficient mosquito detection system with less power consumption. A study conducted by Nasrin Haiand fazalhaq (2018), states that illnesses which are transmitted by vector mosquitoes are significant medical issues in numerous nations. Although numerous mathematical models for infections had been defined, they are altered. As these sicknesses are spread by a typical vector, likenesses in the illness transmission are eminent henceforth it will be gainful to build a general model which envelops the study of disease transmission angles and transmission of mosquito-borne ailments.

Biswas Avan kumar et al, (2013) the majority of current mosquito prevention and treatment tools for the general public use mosquito nets, mosquito swatters, mosquito lamps, and other tools. The Mosquito-attractant is primarily caused by three factors: vision, smell, and temperature. Mosquito-attractant products on the market primarily use phototaxis to attract mosquitos, followed by UV light. Then, using the internal electric shock net, shock mosquitos or inhale mosquitos with a powerful fan to dry them in the air.

An electronic insect repellent is a safer alternative compared to toxic insect repellent. These are electronic devices that have either electromagnetic or ultra sound waves to repel mosquitoes and roaches. The effectiveness of these devices has not been clearly established but the numerous studies foe experiments have shown that these electrical devices are indeed effective in repelling or eliminating pests. Some examples of electronic insects repellents are plug in electronic repellents, ultrasonic transmitters and the electromagnetic lamps. These electronic pest control devices are very affordable (Forster, W.A and lutes, k.I (1985), Jensen, T et al (2000).

L.Okell, (2008) stated that various traditional repellents like coils, chemicals and creams have been used but they are known to have some serious disadvantages. Mosquito repellent creams cause allergic skin reactions.

Chapman R.F, (1982) also talked about a circuit of an electronic pest repellent. It is effective over a diameter around 16 meters. Wide varieties of electric mosquito repellent that are still not in practice so much are available in market. These basically consist of a small hot plate or a chemical mat in order to produce smokes and fumes. These fumes not only affect the mosquitoes and other insects but also adversely to human beings. Some of these devices are costly in operation as well. This Electronic Mosquito Repellent only uses generated ultrasonic waves rather than chemical fumes or harmful toxic smoke. This circuit generates ultrasonic wave as an output in the range of 20 -38 kHz that travels at an angle 45°from the source to cover a wide radius. Ultrasonic wave is not audible to us and hence is harmless to human beings.

- *Evaluation Of Mosquito Repellent Devices*

An electronic device emitting sound waves which, according to label and advertised claims, wards off most female mosquitoes for distances of 0.9 to 2.5 m (3-8 feet) was tested to ascertain its mosquito repellency. Evaluations were conducted in small cage tests, in larger chamber (Peet-Grady Chamber) tests, and in field tests under practical use conditions. The results of all evaluations indicated that the device did not afford protection against the bites of selected species of mosquitoes and tabanids, as claimed by the manufacturer, under the conditions used in this study.".(Frederick W kutz, 1974).

- *Effects of Electronic Repellents Devices On Mosquitoes*

Mosquito-borne infectious diseases cause mortality and global infectious disease burden worldwide. There are several electronic mosquito repellents (EMRs) based on ultrasound have been developed and commercialized to reduce human-mosquito contacts. However, the efficacy of EMRs against mosquitoes is still unclear. In this study, experimental evidence presented that ultrasound of different frequency and sound pressure differentially affects the host-seeking behavior of Aedes aegypti females. Behavioral tests were accompanied by molecular experiments to check whether mosquitoes respond to ultrasound and are there any changes in specific mRNA expression. (Dong-In Kim et al, (2021).

Chemical control, mechanical control and even integrated control have not produced desired results. Commercially available devices or products are appearing intermittently in a variety of formats claiming repellency effects. Despite this, insect repellents are being tried simultaneously; conveniently categorized into – synthetic and plant derived repellents, whose volatility necessitate repeated reapplications, inviting thereby danger of overdosing. Essential oil impregnated candles as repellent even suggested (Schlein Y, muller GC,2008, Abigo et al 2019).

III. METHODOLOGY

The components used to conduct this experiment each plays a vital role in the working principle of the machine. The Components includes;

1. Suction fan
2. Heating element
3. XY-WTH1 temperature and humidity display and control module
4. Trap Mesh
5. Buttons and switches
6. Moisture generator
7. Electric mesh
8. Temperature sensor

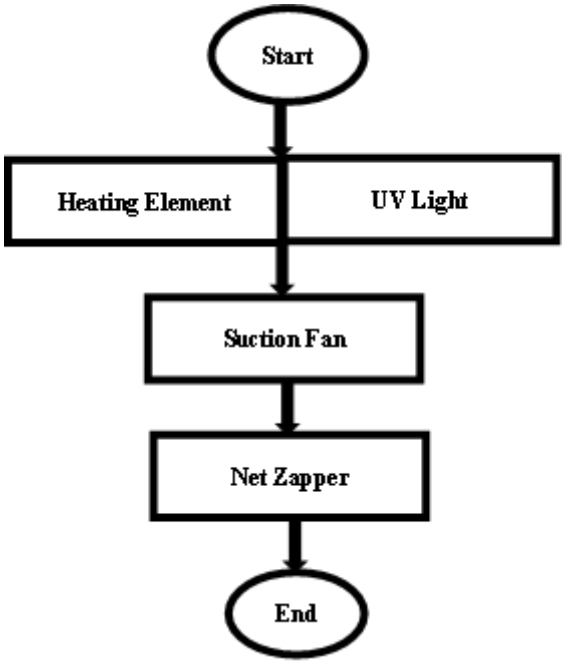

Figure 1: Process for attracting, trapping and eliminating mosquitos

The operation of this device is that the mosquitoes are first attracted and then electrocuted. The advanced mosquito killer machine is one such device with a high voltage electrocuting circuit and an insect attracting UV lamp of 365 nm wavelength. This ultraviolet lamp is mounted in the middle of the machine, slightly above the suction fan. When an insect comes close enough to the Ultraviolet light, the suction fan then drags the mosquitoes down to the electric wire mesh, the dielectric breaks down and current flows through the insect's body. Electrocuting the insect doesn't require it to touch both the wires as an arc forms in the air gap over 1800 V.

Based on test carried out the results shows that this doesn't only apply to mosquitoes but to other small nocturnal insects as well.

IV. RESULTS

- *Testing and Evaluation*

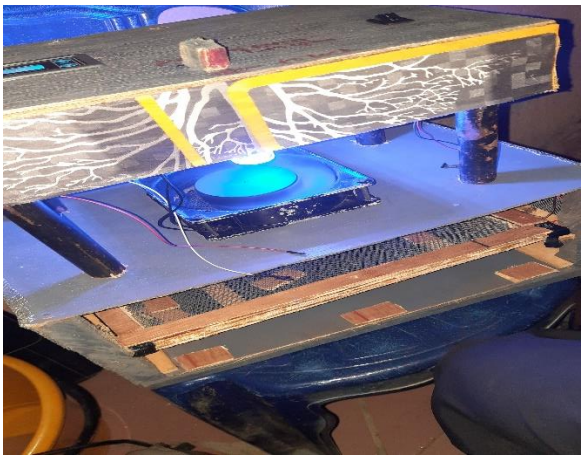

Figure 2:

The advanced mosquito killer machine will not only trap and eliminate mosquitoes. But when in use, it will prevent mosquitoes from paying so much attention to the user when sleeping at night. The reason for this is because the advanced mosquito machine is made to mimic some human attributes that draw the attention of mosquitoes examples; heat generation, moisture release (sweat) etc. And light which generally attracts insects is also included in the machine to help mosquitoes navigate around the machine.

The machine has a suction fan that then drags the mosquito(es) into the machine to prevent escape. Below the suction fan is an electric wire mesh charged with a high voltage, enough to kill mosquitoes and other small insects and at the same time not be harmful to humans. During the day, the machine is cleaned and dead mosquitoes are removed, and then the machine is ready to be used again. This process makes it easier to get rid of mosquitoes without endangering human health with the use of insecticides.

Table 1: Indoor Testing of Device

Trial	Temp (°C) of Attractor	Mosquitoes Attracted	Mosquitoes Trapped	Mosquitoes Eliminated
1	35	7	7	7
2	36	8	7	7
3	37	8	8	8

4	38	7	7	7
5	39	9	8	8

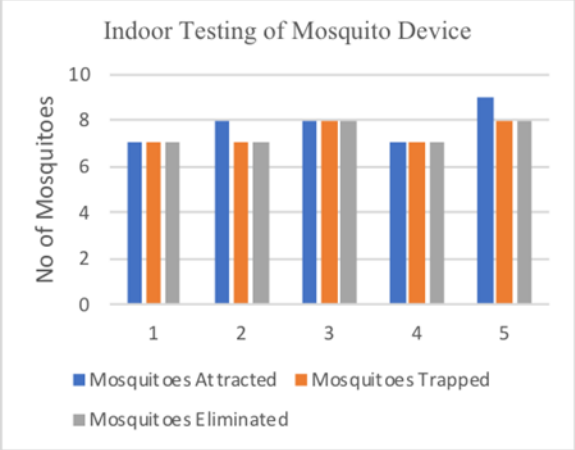

Figure 3: Indoor Testing of Mosquito Device

Table 2: Outdoor Testing of Device

Trial	Temp (ºC) of Attractor	Mosquitoes Attracted	Mosquitoes Trapped	Mosquitoes Eliminated
1	40	14	14	11
2	41	13	10	8
3	42	15	13	11
4	43	10	9	9
5	44	13	11	10

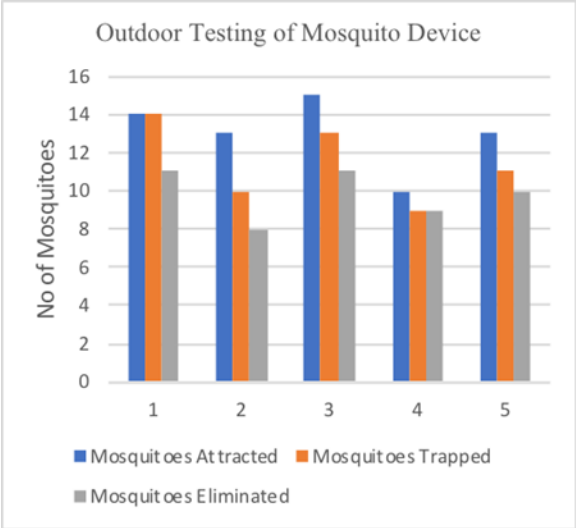

Figure 4: Outdoor Testing of Mosquito Device

CONCLUSION

Some of these consequences on the environment like using insecticide sprays can damage useable water, and human skin. Most of these insecticides are very harsh and affect human health. We can agree that mosquito nets are ineffective nowadays as mosquitoes have been able to adapt to the harshness. The mosquito nets instead of killing mosquitoes and preventing them from biting people, end up causing irritation to the human skin. The use of chemicals has been researched and concluded to be harmful to plants, some other insects and even humans. Some of these chemicals used in the environment are harmful to agricultural crops which serves as food for humans. This mosquito killer machine was therefore designed and tested to lure, trap and eliminate nearby mosquitoes. This project has been tested and has been proven to be safer, more reliable, eco-friendly, more efficient in the reduction of mosquito population.

REFERENCES

[1] Abigo, I., Faisal, T., Iwan, M., Al-Assadi, H.M., & Ramli, H. (2012). Programming ABB Industrial Robot for an Accurate Handwriting. Latest Advances in Systems Science and Computational Intelligence. Pages 80-85.

[2] Abigo, I. & Okwu, I. & Nkoi, B. (2019). Application Of Artificial Neural Network In Optimization Of Soap Production. World Journal

of Engineering Research and Technology. Vol. 5 Pages 128-138.

[3] EK Patel, EK,Gupta, A. and Oswal, R.J (2012) A review on mosquito repellent methods. International journal of pharmaceutical, chemical and biological sciences, S 2012, 2(3), pages 310-317.

[4] Joseph C. Dickens, Jonathan D. Bohbot(2013). A review of classification of mosquito repellent United States department of agriculture, Agricultural research service, Henry A. Wallace Beltsville Agricultural research center, plant sciences institute, invasive insect biocontrol and behaviour laboratory, Beltsville, MD,USA. Pg 1.

[5] Afeefa chaudhry, A review article of mosquito control methods and their limitations, Rasheda jabeen, Beenish sarfraz and sumaira mazhar(2019) Department of biology, La hore Garrison University, lahore-pakistan. Center of excellence in molecular biology, Punjab University, lahore-pakistan.

[6] Sana Naseem, Prof Dr. Muhammad faheem malic and Talhat manir(2016). A journal of Entomology and Zoology studies, Pakistan.2016; pages 73-79.

[7] Robert I. Rose (2001). An article on pesticides and public health integrated methods of mosquito management. US Environmental protection agency, Washington DC, USA.

[8] Batool, k; Alem; Wu, S; liu W; zhao G; Chen m, Wang J; Xuj; Huang T; panX; et al. Transcriptional analysis of Aedes aegypti in response to mosquitocidal Bacillus thuringiensis LL p29 Toxin. Sci Rep 2018, 8, 12650.

[9] Giovanni Benilli, Claire L Jeffrey's, Thomas walker. An Article on biological control of mosquito vectors: past, present and future. Insects 7 (4), 52, 2016.

[10] Baraack L, Hunt R, koekemoer LL, Gericke A, munhenga G, Haddow AD, et al. An article on Bating behaviour of African malaria vectors: parasites and vectors. (2015).

[11] Ayan kumar Biswas, Nahianalam Siddeque, Bing Bang Tian, Enough wrong and Kevin A cailout "Design of a fiber-optic sensing mosquito trap. "/EEE sensors Journal, vol. 13, issue:11, PP.45-59, march 2014.

[12] Hailand Fazal Haq "Efficiency study of indigenously Developed mosquito repellent Bite free and its comparison with commercially available mosquito repellent," 2018.

[13] Forster, W.A and lutes, K.I. " Tests of ultra sonic Emissions on mosquitoes Attraction to Hosts in flight Chambers," journal of the American mosquito control Association, 1(2). PP. 199-202, 1985

[14] Jensen, T. Lamp R, Slamecka M.C and Novak R.J, " field efficiency of commercial Anti-mosquito products in illinois," Journal of American mosquito control Association, Vol. 16, No. 2, PP. 148-152, 2000.

[15] Ibrahim A.G, oyedun, O.D, Awojoyogbe, and Okeke O.B, " Electronic pest control Devices: A review of their Necessity, controversies and a submission of Design Considerations." S.S N. Department of physics; Federal University of Minna, Nigeria. The international journal of engineering and science (IJES), Vol 2, PP. 2319-1805, 2013.

[16] Chapman, R.F; " The insects structure and function," 3rd edition,london: Huddersfield and Stoughton, 1982.

[17] Frederick W kutz. Evaluations of an electronic mosquito repelling device. Mosquito news 34(4), 369-75, 1974.

[18] Dong-In Kim, Rustem Ilyasov, Ural Yunudbav, Sung-Hwa lie, Hungary wook kwon. Behavioural and molecular responses of Aedes aegypti to ultra sound. Journal of Asia-Pacific Entomology 24(1), 429-435, 2021.

[19] Schlein Y, Miller GC(2008). An approach to mosquito control: using the dominant attraction of flowering Tamarix jordanis trees against culex pipiens. Journal of medical entomology 45: 384-390.

[20] Biswas Avan Kumar, Nahian Alam Siddique Bing Bing Trian, Enough wrong, Kevin A Cailoüet and Yuichi motion " Design of fiber-optic sensing mosquito trap." /EEE sensors Journal B, no. 11(2013): 4423-4431.

[21] L.Okell " Reduction of transmission from malaria patients by Artemisisnin combination therapies." Malaria joirnL, 7: 125; 2008.

[22] Manġare P,M.N (2012) A comparative study of the transmission parameters of sound of mosquito predators and EMR. International journal of biophysics, 2-4.

[23] Li-C-X, Zhang Y-M, Dong Y-M, Dong Y-D, Zhou M-H, Zhang H-D, Chen H-N, et al. An unmanned aerial vehicle-mounted cold mist spray of permethrin and tetramethylfluthrin targeting Aedes albopictus in China.J Am mosquito control Association 2016; 32-59-62.

[24] Rasmussen E. Drones against vector-birne diseases Sci-robot. 2020; 5: e abc7642.

[25] Fillinger U, Lindsay SW. Carval source management for malaria Control in Africa: myths and reality. Malar j. 2011; 10:353.

[26] Fillinger U, Lindsay SW. Larval source management for malaria control in Africa: myths and reality. Malar j. 2011; 10:353.