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Genetically modified mosquitoes for a better world

Swastika Mohanta
Dept. of Biotechnology, University of Engineering and Management, Kolkata
Corresponding: godastika@gmail.com

Abstract

Discoveries of the scientific world have made our life better. Commencing genetically modified mosquitoes will help us avoid mosquito-borne diseases such as malaria. Mosquitoes cause more human suffering than any other organisms as they carry dreadful diseases like malaria, West Nile virus, yellow fever, dengue and over a million people die worldwide from mosquito-borne diseases every year. They are debilitating and deadly in tropics and subtropical areas. The malarial parasite in particular has started to develop resistance to currently available drugs. Even insecticide spraying is now a challenge in many mosquito species like *Aedes egypti* which is a vector for viruses such as chikungunya, dengue, zika. These transgenic mosquitoes will be released to interact with wild-type populations and through inter-specific mating, the mutated gene will be transferred which will impede the plasmodium evolution with its species.

Keywords

Genetically modified mosquitoes, Malaria, Transgenic, Insecticides, Tetracycline, Antibiotic, Self-limiting genes

1. Introduction

Scientists after dengue breakout in Florida proposed first release of Gm mosquito, OX513A *Ae. aegypti,* in United States[1]. A new approach of GM mosquitoes in Florida and Texas, they are genetically modified male *80s egypti* mosquitoes known as *ox-5034*, known as *"Friendly™"* mosquitoes developed by *Oxitec*. The 80s egyptian mosquito eggs are injected with short pieces of DNA that contain a self-limiting gene with a fluorescent marker gene, which is a tetracycline transcriptional activator variant or ttav gene. When this gene is introduced into the mosquito's genome, it will encode a protein that blocks the transcriptional machinery with other genes helping in mosquitoes development. So, to make it economically effective the lethal gene need to be pass on to the offsprings, hence the lethal gene has a corresponding antidote to keep the larvae alive, tetracycline, an antibiotic which cannot block the lethal t-tav protein transcription of the other essential mosquito genes keeping the GM larvae alive until adulthood[2].In lab mosquito eggs injected with self-limiting genes whereas the GM mosquito larvae are reared in water containing

tetracycline which can then develop normally into adult mosquitoes. Now the adult GM mosquitoes will be released and breed with wild non-GM mosquitoes. Their offspring will inherit the lethal t-tav gene and so without tertacycline in their environment they don't survive into adulthood. To make this technology more effective scientists ensured that the lethal gene should only kill the female offsprings for that one copy of t-tav gene remains in some of the male offspring of the injected mosquitoes and then pass it on to their offspring.This process can be further applied to most danger mosquitoes like *Anopheles sp.*, *Culex sp.* which carries the gene of dreadful diseases like malaria, West Nile fever, Japanese encephalitis[3]. Field trails in Brazil began in 2011 with the first generation of GM mosquito, *ox-513a* and resulted that the local 80s eqypti population was reduced by 80-95% after a year of consistent releases. The GM male mosquitoes were released by opening release devices through the window of a moving car and when mated with local female populations their offspring inherited the ttav gene could not survive. Critics claim that the suppression of mosquitoes are 60-70% but its better than insecticides spraying which receive 50% suppression. Oxitec has also tested the second generation, *ox-5034*, which has received 98% suppression in 13-weeks. GM mosquitoes have been successfully used in parts of Brazil, the Cayman Islands, Panama and India to control *Ae. aegypti* mosquitoes[4].

2. Literature Review

Aedes aegypti, the most hazardous type of mosquito, is capable of spreading diseases such as dengue, Zika, malaria, and chikungunya to humans. The year 2015 saw a total of 214 million malaria infections worldwide, resulting in the deaths of 438,000 people, with a majority of the victims being children residing in Africa[5]. The genetically modified mosquito, due to its fatal mutation, is unlikely to survive and reproduce in the wild. As a result, genetically modified males need to be periodically introduced to prevent the population from growing uncontrollably. Oxitec, a biotechnology company, has carried out experiments with this technique on *Aedes aegypti* mosquitoes in various locations worldwide, including Panama, the Cayman Islands, Malaysia, and Brazil[6].Oxitec reported that after releasing their genetically modified mosquitoes in Brazil's Eldorado district, there was a 91% decrease in dengue fever cases, while the Piracicaba district saw a reduction of 52%[7].Gaining the approval and assistance of the surrounding community is a crucial obligation from a legal, ethical, and practical standpoint when conducting field experiments involving genetically modified mosquitoes[8]. The scientists planning to conduct field experiments involving genetically modified mosquitoes in Florida were required to obtain permission from the Food and Drug Administration and the Monroe County Mosquito Control District, as discussed in the community engagement cases below. As legal requirements are typically formal and procedural, this article will concentrate on ethical necessities. Ethically, the principles of

autonomy and justice stipulate that individuals who are expected to be affected by a proposed public health study or intervention should have substantial say in the decision-making related to the intervention[9]. John Morris III, a physician from Key West, expressed concern through a letter that the GM mosquitoes could potentially carry antibiotic-resistant bacteria as they were exposed to tetracycline. He then requested Oxitec to provide information regarding antibiotic resistance in their mosquitoes. In reply, Oxitec researchers stated that they had conducted extensive studies on this matter and deemed the risk of the mosquitoes transmitting antibiotic-resistant bacteria to the human population as minimal[10].

3. Future Prospects

Oxitec is collaborating with *Gangabishan Bhikulal Investment and Trading Limited (GBIT)* to develop and produce the *RIDL technology* in India, to make India's own GM mosquitoes. Two types of genetically modified, *Bisex RIDL strain* and *Female-specific RIDL (fsRIDL)* strain can be designed to die at different life stages. Sexes can be separated by excluding the supplement from the diet of the final, pre-release generation where male progenies will only exist. Out of 112 genera of mosquitoes only 3 *(Aedes, Anopheles, Culex)* bear the primary responsibility of spreading human diseases. Critics said that their is a risk of passing genes from GM mosquitoes to human. But transfer of genetic materials does not occur like that, mosquitoes have been feeding on human blood for 100 million years still there is no evidence of gene transfer via blood feeding. Livestock who consume GM crops do not have any trace of genetic material in their body. One day if we want to kill off all the disease-bearing mosquitoes we need this technology to save millions.

4. Conclusion

Releasing genetically modified organisms (GMOs) into the environment could become more significant in the effort to prevent certain kinds of illnesses transmitted by vectors[11]. While the present investigations have centered on mosquitoes as disease carriers, scientists have suggested modifying mice genetically to make them immune to Lyme disease[12]. Additional possibilities for genetic modification are black flies (which carry Onchocerciasis or river blindness), aquatic snails (which transmit Schistosomiasis), Tsetse flies (responsible for African sleeping sickness), and Triatomine bugs (the cause of Chagas disease).

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