Malaria control needs longer-lasting repellents. We're a step closer to finding one

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A volunteer testing mosquito a repellant. Credit: António Benjamim Mapossa

Malaria is one of the leading causes of illness and death around the world. The disease is primarily caused by the bite of mosquitoes carrying a parasite. In 2019, around 229 million malaria cases were reported with an estimated number of 409,000 deaths. Most of the reported cases occurred in sub-Saharan Africa. Children younger than five years and pregnant women are most prone to malaria.

To prevent malaria, the World Health Organization (WHO) recommends spraying insecticides indoors and using bed nets treated with long-lasting insecticide.

These interventions have one big flaw, however. They focus on minimizing malaria infections indoors. Infections can still occur outdoors. And in some African countries resistance to insecticides—especially pyrethroids—is emerging. So new methods to control mosquitoes are needed urgently.

Numerous repellent-based products, such as creams, roll-ons and sprays, are available on the market for outdoor protection. Most of these have a very short period of protection—a few hours. People need to be protected from mosquito bites for longer.

To address this problem our research project aims to develop a new, cost-effective product such as an anklet or bracelet to repel mosquitoes for an extended period.

A possible method of achieving this is to use polyolefin strands filled with mosquito repellents (DEET and icaridin). Polyolefins are the most extensively used group of thermoplastics polymers because of their strength, light weight, low cost, easy processability and good water barrier properties. This would make the total cost of the repellent-based product affordable.

Our research

Our project is a collaboration between the Institute of Applied Materials and the Institute for Sustainable Malaria Control at the University of Pretoria in South Africa alongside Martin Luther University Halle-Wittenberg in Germany and Eduardo Mondlane University in Mozambique.

In essence, we apply our skills in chemical and polymer technology to design and develop products that may help to reduce the malaria burden.

We're trying a technology that releases chemicals from the plastic in a controlled way. We want the

active ingredients of the mosquito repellent to emerge gradually and at the same concentration over a prolonged period of time.

The polymer product acts as a reservoir for suitable repellents by trapping the active ingredients inside a polymer matrix. The release rate is controlled by a membrane-like structure at the surface of the system.

We tested the polymer strands filled with repellents—DEET and icaridin—over a period of 12 weeks. This means each repellent-polymer strand lasts 12 weeks. DEET is the key active ingredient in many commercial mosquito-repellent formulations. It is also an environment-friendly compound. Icaridin is also a safe and effective repellent that has been available for many years for mosquito application. We tested the strands under controlled conditions in an insectary to determine their activity against mosquitoes. Caged mosquitoes were offered the opportunity to feed on both treated and untreated body parts of human volunteers. Three hundred mosquitoes were placed in a large netting cage. The volunteers could put their legs into the cage through portals.

The test strand, 3 meters long, was wound around one leg of a volunteer, leaving the other leg fully exposed. Both legs were then inserted into the cage, one leg per entry hole, and the person stood still for five minutes. After five minutes two other people used flashlights to count the number of mosquitoes on the lower leg of the test person. The numbers of mosquitoes on the treated and untreated legs were recorded separately.

The result showed that most of the mosquitoes chose to feed on untreated legs. The novel repellent-based polymer product has a longer lifespan—12 weeks more than commercially available repellents. It has the added benefit of not only repelling mosquitoes, but killing them too if they make contact with it. And the polyolefins are widely available and cost effective. This would make the final product affordable—an important consideration.

More extensive and rigorous entomological and epidemiological testing would have to be done on products like this before they could become commercially acceptable.

Looking ahead

Malaria cannot be eliminated by just one vector control method. An integrated multidisciplinary approach is needed.

New, safe and sustainable methods need to be researched and developed to overcome current resistance trends and prevent transmission of malaria from all angles.

Our research opens the door to a new mosquito repellent formulation that improves the armory against malaria.