News Release
Kao Corporation

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FOR IMMEDIATE RELEASE

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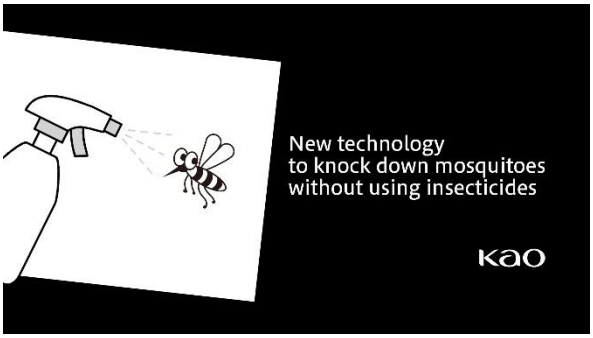
Focusing on the Surface of the Mosquito's Body to Control Mosquito Behavior Using a Surfactant

New Technology Development to Eradicate Mosquitoes Without Using Insecticides

The Personal Health Care Products Research Laboratory of Kao Corporation, in collaboration with the Laboratory for Circuit Mechanisms of Sensory Perception at the RIKEN Center for Brain Science of RIKEN (National Research and Development Agency), has discovered the application of an aqueous surfactant solution with low surface tension inhibits mosquito flight behavior and effectively knocks them down. Applying this finding, Kao has developed technology to easily eradicate mosquitoes by applying the aqueous surfactant solution on mosquitoes.



New technology to knock down mosquitoes without insecticides - YouTube

The research findings have been published in *Scientific Reports*[*1], an online journal published by Nature Research, and presented at the 6th Asia Dengue Summit (June 15–16, 2023, Bangkok).

*1 Kato-Namba A., Iida T., Ohta K., Suzuki M., Saito K., Takeuchi K., Sakamoto M., Kazama H., Nakagawa T., Surfactants alter mosquito's flight and physical condition. *Sci Rep*, **13**, 2355 (2023) https://doi.org/10.1038/s41598-023-29455-6

Background

Mosquitoes transmit many serious vector-borne diseases such as Dengue fever and malaria. Among them, the incidence of people infected with Dengue fever globally has been increasing, driven by global warming and rapid urbanization, which have expanded mosquitoes' habitat. Large numbers of people have been afflicted by severe cases of Dengue fever.

In addition to developing therapeutic drugs and protecting people through vaccines and the use of mosquito repellents, eradicating mosquitoes is an effective means of reducing the spread of mosquito-borne diseases. Pyrethroid insecticides are used in many regions with widespread incidence of mosquito-borne diseases. Meanwhile, mosquitoes in Southeast Asia and elsewhere are known to be

developing resistance to pyrethroids, meaning that fewer mosquitoes are killed by the insecticides. This points to the need for development of various mechanisms of eradicating mosquitoes that can be sustainably used.

The Search for a Mechanism to Prevent Mosquitoes from Flying

Kao has been engaged in technology development aimed at inhibiting and preventing mosquitoes from flying, with a focus on the mosquito's body surface and wings. The surface of the mosquito's body (Figure 1) is covered with very fine ridges and coated in a hydrophobic substance similar to wax, which makes it very difficult for water to wet a mosquito's body. Mosquitoes are therefore able to repel water from the surface of their wings and body, stay dry even in the rain, and lay their eggs and hatch on the surface of water.

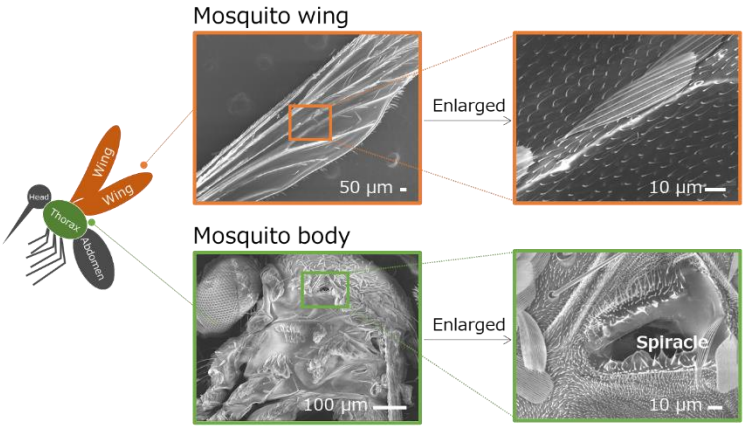


Figure1. Surface of a mosquito wing and body observed with a scanning electron microscope

In 2020, Kao developed technology that prevents mosquito bites by preventing mosquitoes from landing on people's skin by wetting mosquitoes' legs with silicone oil[*2]. From this finding, Kao hypothesized that wetting mosquitoes' body and wings could alter their flight behavior, and focused on surfactants as the optimum mechanism for wetting them.

*2 Kao News Release dated December 9, 2020 Technology for Preventing Mosquito Bites Developed by Creating a Skin Surface Mosquitoes Dislike —Protecting Against Mosquito-borne Infectious Disease—

Surfactants work at the interface of two different substances and have the ability to change their properties. For example, when a surfactant works at the interface of water and oil, the surfactant allows oil and water to mix, which normally would not be possible. In the same way, adding a surfactant to water lowers the surface tension of the water solution and makes it easier to wet a surface that would otherwise repel water.

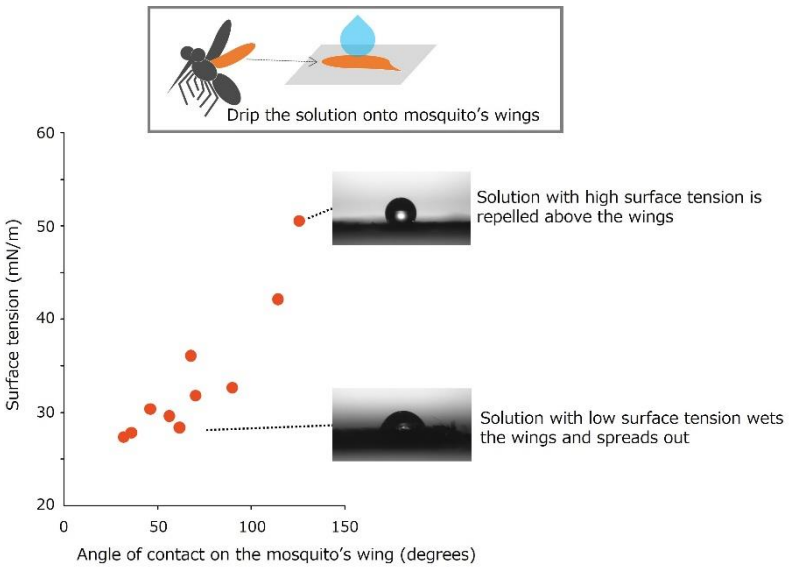


Figure 2. Wettability of mosquitoes' wing depends on the surface tension of the solution

Kao has discovered that deploying this property of surfactants makes it possible

to wet the hydrophobic surface of the mosquito's body that normally repels water. In addition, after comparing various aqueous surfactant solutions, Kao found that using a surfactant that is able to dramatically reduce surface tension can efficiently wet the surface of the mosquito's body and wings (Figure 2).

Spraying mosquitoes with water does not alter their ability to fly since they are able to repel the water. However, Kao discovered that simply spraying mosquitoes with a mist of an aqueous surfactant solution, which is able to efficiently wet the surface of the body and wings, can easily make mosquitoes lose the ability to fly.

Preventing Mosquitoes from Flying by Wetting Their Wings

Together with RIKEN, Kao analyzed what happens to mosquito wings when water or an aqueous surfactant solution is applied to them (Figure 3). If water is applied to mosquitoes when they are in flight, their wings are able to repel the water, so the mosquitoes can continue to fly. On the other hand, the analysis verified that if an aqueous surfactant solution is applied, mosquito wings become wet and unable to move. Mosquitoes move their wings at a faster rate than other flying insects, which allows them to maintain a precise flight path and position. The ability of the aqueous surfactant solution to prevent mosquitoes from maintaining their precise flight behavior and knock them down is attributed to how the solution rapidly coats the wings and body of mosquitoes.

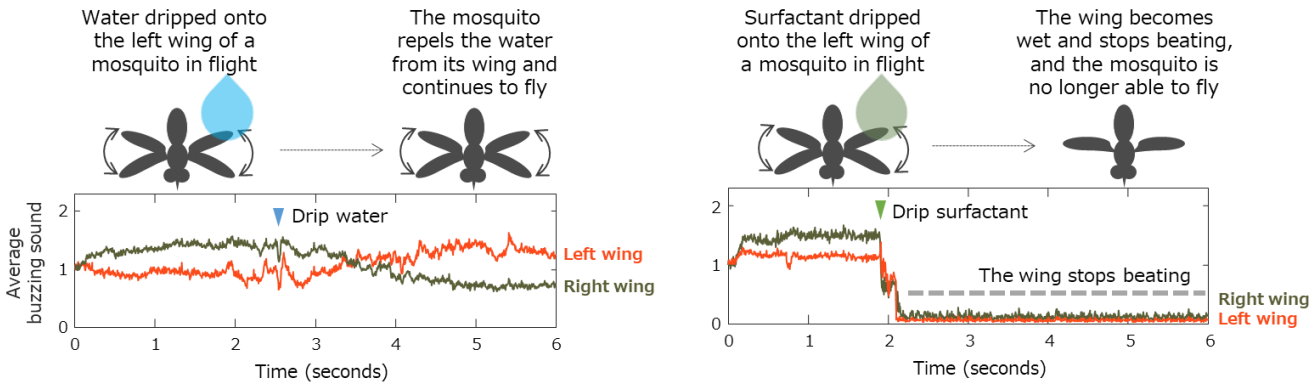


Figure 3. Mosquitoes' flight after their wings are wet

Knocking Down Mosquitoes by Covering the Spiracles on Their Body

In addition, Kao has found that mosquitoes can be effectively knocked down by covering them with a solution with low surface tension (Figure 4). Insects have small openings on their body called spiracles (Figure 1) through which they take in air. It is known that some insects die when their spiracles are blocked. Being covered in a solution with very low surface tension that blocks oxygen from being taken in through the spiracles is thought to cause this knock-down effect.

As previously stated, knocking mosquitoes down by using an aqueous surfactant solution to wet their

wings and body employs a completely different mechanism than pyrethroid insecticides. Mosquitoes depend on the ability to repel water from their body to survive, so it is expected that mosquitoes will not readily gain resistance to the physical mechanism of wetting their body that effectively causes their death.

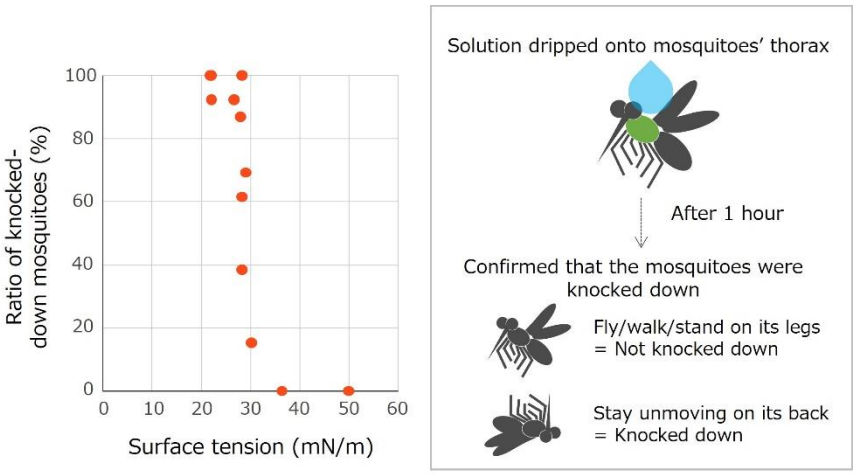


Figure 4. Knocking-down effect depends on the surface tension of the solution

Conclusion

Using its expertise in interface science and observations of mosquito behavior and body structure, Kao has discovered a mechanism to eradicate mosquitoes by wetting them using a surfactant. Technology to knock mosquitoes down using a surfactant-based physical mechanism is a different mechanism of action than conventional pyrethroids and other insecticides. It is thought that mosquitoes will not be able to readily gain resistance to this mechanism, suggesting that it could be a sustainable solution to eradicate mosquitoes. Kao plans to put this technology into practical use to contribute to protecting people from mosquito-borne diseases.

About Kao

Kao creates high-value-added products and services that provide care and enrichment for the life of all people and the planet. Through its portfolio of over 20 leading brands such as *Attack*, *Bioré*, *Goldwell*, *Jergens*, *John Frieda*, *Kanebo*, *Laurier*, *Merries*, and *Molton Brown*, Kao is part of the everyday lives of people in Asia, Oceania, North America, and Europe. Combined with its chemical business, which contributes to a wide range of industries, Kao generates about 1,550 billion yen in annual sales. Kao employs about 35,400 people worldwide and has 136 years of history in innovation. Please visit the Kao Group website for updated information.