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Cooling pollen sunscreen can block UV rays without harming corals

by Nanyang Technological University

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Close up of the sunscreen applied to skin (left) and the raw camellia pollen on the right. Credit: NTU Singapore

Materials scientists from Nanyang Technological University, Singapore (NTU Singapore) have invented the world's first pollen-based sunscreen derived from *Camellia* flowers.

In experiments, the pollen-based sunscreen absorbed and blocked harmful ultraviolet (UV) rays as effectively as commercially available sunscreens, which commonly use minerals like titanium dioxide (TiO_2) and zinc oxide (ZnO).

In laboratory tests on corals, commercial sunscreen induced coral bleaching in just two days, leading to coral death by day six. Each year, an estimated 6,000 to 14,000 tons of commercial sunscreen make their way into the ocean, as people wash it off in the sea or it flows in from wastewater.

In contrast, the pollen-based sunscreen did not affect the corals, which remained healthy even up to 60 days.

In other tests, the pollen-based sunscreen also demonstrated its ability to reduce surface skin temperature, thereby helping to keep the skin cool in the presence of simulated sunlight.

The innovation has been [published](#) in *Advanced Functional Materials*.

Materials scientists from Nanyang Technological University, Singapore (NTU Singapore) have invented the world's first pollen-based sunscreen derived from Camellia flowers. Credit: NTU Singapore

Lead author of the study, Professor Cho Nam-Joon, President's Chair in Materials Science and Engineering at NTU Singapore, said that pollen is widely available and often consumed for its health benefits.

"We know that pollen is naturally UV-resistant, as its shell needs to protect its inner contents from harsh environmental conditions, including sunlight. Our research aimed to develop a way to process pollen grains into a gel-like form, so that they can be easily applied to human skin," explained Prof Cho, who is also NTU's Director of Flagship Programs and the Director of the Center of Cross Economy at NTU.

"We wanted to develop an affordable and effective natural sunscreen that is non-allergenic to humans and eco-friendly to the environment. This is where NTU leveraged our deep expertise in

materials science and engineering to develop a sustainable real-world solution that has an impact on both humanity and the Earth."

The study is part of NTU's push for sustainability, one of the university's key research pillars aimed at developing real-world solutions with environmental impact.

Benefits of sunscreen

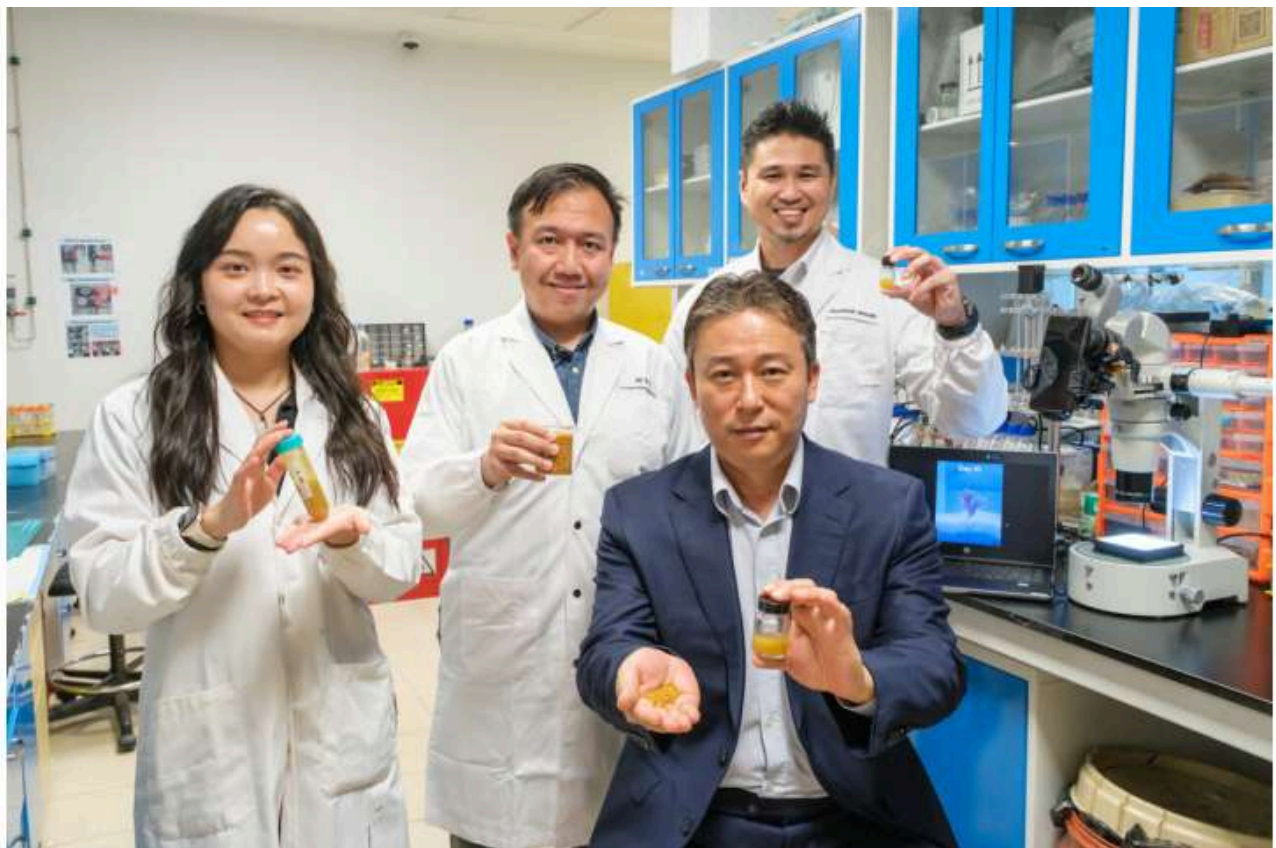
Sunscreens are designed to absorb or reflect UV rays away from the skin, as prolonged UV exposure can lead to skin problems such as sunburn and skin cancer.

However, many commercial sunscreen chemicals are harmful to marine life, particularly corals.

In contrast, pollen is coated in a substance called sporopollenin—one of the toughest natural biopolymers—which protects the genetic material during transit. It is so resilient that it has been found in fossils millions of years old.

Using a proprietary water-based process that does not involve harsh chemicals or high heat, Prof Cho's team processed both Camellia and Sunflower pollen by removing the inner contents of the pollen shell and converting it into a microgel formulation, similar to those used in skincare products.

When applied, the microgel layer is just microns thick—barely the width of a human hair—and transparent to the naked eye.





In animal experiments conducted by collaborators at Seoul National University, it was shown that both Camellia and sunflower pollen microgels effectively blocked UV rays and reduced skin cell damage and inflammation, with Camellia pollen performing better in their comparative tests.

When benchmarked against a commercial sunscreen containing chemical and mineral filters, both pollen-based microgels demonstrated comparable, if not superior, UV protection.

In tests simulating sunlight exposure, the Camellia pollen microgel was found to regulate skin temperature more effectively than commercial sunscreen, keeping the skin temperature 5 degrees Celsius cooler for 20 minutes.

This cooling effect is attributed to the pollen's natural properties, which absorb less energy in the visible to near-infrared spectrum—the wavelengths largely responsible for heat generation.

The pollen-derived sunscreen has been tested to have a Sun Protection Factor (SPF) of about 30, meaning it blocks approximately 97 percent of the UV rays.

Also, not all types of pollen cause allergy and Camellia pollen is generally considered non-allergenic, as it is a self-pollinating flower.

Giving an independent comment, dermatological diseases expert Associate Professor Andrew Tan Nguan Soon from NTU's Lee Kong Chian School of Medicine (LKCMedicine), noted, "Beyond its eco-friendly credentials and UV-blocking performance, the pollen-based sunscreen uniquely cools the skin, a benefit not typically found in commercial sunscreens."

"By naturally reducing skin temperature during sun exposure, this sunscreen promises enhanced comfort and healthier skin, making it especially compelling to explore further for stability under various storage conditions and scalability of sustainable pollen harvesting," added Prof Tan, who is the Provost's Chair in Metabolic Disorders and Vice Dean (Innovation and Enterprise), LKCMedicine.

Ocean biogeochemist Associate Professor Patrick Martin, from NTU's Asian School of the Environment, gave his independent view: "Many types of chemical pollutants, including sunscreens, enter the ocean each year, and marine life can be highly sensitive to them."

"Numerous lab studies have shown that certain sunscreen compounds can harm corals, although these are often conducted at concentrations higher than what is typically found in the environment. It's difficult to pinpoint how much harm each factor contributes to complex marine ecosystems, so any effort to reduce chemical pollution is welcome. This pollen-based sunscreen is a promising step towards protecting both human health and marine life."

More information: Nature's Guard: UV Filter from Pollen, *Advanced Functional Materials* (2025). DOI: [10.1002/adfm.202516936](https://doi.org/10.1002/adfm.202516936). [advanced.onlinelibrary.wiley.c1002/adfm.202516936](https://advanced.onlinelibrary.wiley.com/doi/10.1002/adfm.202516936)

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