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Insect repellents

Insect repellents are agents that are used to protect the body from the bites of insects that can cause local or systemic effects. Whilst some bites cause only local skin irritation, some can cause serious illnesses and possibly death as the insects act as carriers or vectors of diseases. Mosquito bites are a common problem throughout the world and in some areas the mosquitoes are the vector of potentially serious diseases including malaria, West Nile virus, [dengue fever](#), and [chikungunya fever](#). [Lyme disease](#) is spread via the bite of infected ticks on the skin.

Insect repellents currently fall into two categories: chemical repellents and natural plant-derived repellents. The most well-known and well-used chemical repellent is DEET (N, N-diethyl-3-methylbenzamide, previously called N, N-diethyl-m-toluamide). Other chemical insect repellents include IR3535, MGK-326 and MGK-264. The latest chemical agent proving to be as effective as DEET is a piperidine-based repellent called picaridin. Plant-based insect repellents are becoming increasingly popular because of their low toxicity but to date have not shown to be as effective as DEET. These include citronella, soybean oil and eucalyptus products.

What makes an ideal insect repellent?

The ideal insect repellent should aim to have the following properties:

- Active against a wide variety of biting insects
- Prolonged activity (remain effective for at least 8 hours between applications)
- Non-irritating to the skin and mucous membranes
- Cosmetically appealing (odourless or have a pleasant odour and greaseless)
- No systemic toxicity
- Resistant to abrasion, washing and sweating
- Chemically stable and doesn't react with commonly used plastics
- Economically viable for widespread use.

Currently there are no insect repellents that meet all the criteria listed above. It is extremely difficult to find a single active chemical that is effective against the many different species of disease-carrying insects. DEET is the most broad-spectrum and most effective insect repellent that has been developed to date. However it has recently been discovered that the chief malaria-carrying mosquito, *Anopheles albimanus*, in the United States is becoming resistant to DEET.

How do insect repellents work?

To understand how insect repellents work we need to understand how biting insects find their hosts. Studies of mosquitoes have shown that these insects use a combination of sight, heat and smell to locate a blood meal. They are attracted to the smell of carbon dioxide, lactic acid and other odours from the skin, as well as warm and moist skin.

Most insect repellents including DEET work on the principle of creating a vapour barrier that deters the insect from coming into contact with the skin. To the insect the vapour has an offensive smell and tastes bad.

Currently under investigation by scientists with the International Anopheles Genome Project is the olfactory

biology of the main malaria-carrying mosquito *Anopheles gambiae*. To find a host to feed on, mosquitoes use their olfactory binding proteins (OBPs) to detect human-specific odours that are released by human skin. Scientists believe that by destroying the OBPs of mosquitoes this should stop them from targeting human hosts and effectively decrease bites.

Commonly used insect repellents

DEET

- Chemical name is N, N-diethyl-3-methylbenzamide.
- Developed in 1946 and widely marketed for use from the 1950s onwards. Current worldwide use exceeds 200 million people annually.
- Available in concentrations ranging from 5–100% but most proprietary formulations are between 5–40%. In most situations, a concentration of 10–35% DEET will provide adequate protection. DEET is available in a range of formulations including solutions, lotions, creams, gels, aerosol and pump sprays, and impregnated towelettes.
- Further product development by 2 manufacturers has resulted in extended-release formulations of DEET. One of these is Ultrathon™, a 33% DEET cream that provides up to 12 hours of greater than 95% protection against mosquito bites. It is the standard issue repellent given to the US military.
- When used properly DEET has an excellent safety record. Over the last 50 years of use there have been less than 50 significant cases of DEET toxicity reported. In most of these cases inappropriate and/or incorrect use of DEET was found.
- DEET should be used with caution when used in combination with sunscreens. The effectiveness of the sunscreen may be reduced by one third so more frequent application of the sunscreen may be necessary. It has also been found that there may be increased systemic absorption of DEET when combined with sunscreen, hence concerns for potential toxicity. Further studies are needed concerning this area.

Picardin

- Chemical name is 2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester.
- Picardin is the active ingredient of insect repellents most commonly found in Europe and Australia. It is available in concentrations of 7–20%.
- It is odourless and does not feel sticky or greasy when applied. It also appears to have low potential for toxicity.
- It appears to have similar efficacy to DEET but there is little comparative data available.

Permethrin

- Permethrin is an insecticide that requires direct contact with the insect for it to work. It is not suitable for skin application but is used in agriculture, home pest control and public health programmes.
- It should be sprayed directly onto clothes, tent walls, and mosquito nets. Items need to be sprayed for 30–45 seconds and then allowed to dry for 2–4 hours before being worn.
- Permethrin spray is almost odourless and retains its potency for at least 2 weeks. It should be reapplied after every 5 washings.
- Mosquito nets or bed nets treated with permethrin have helped prevent many cases of malaria worldwide.
- It has been associated with toxic effects at high doses. These include eye and skin irritation, tremors, loss of coordination, hyperactivity and paralysis.

Botanicals

- Botanicals or plant-derived products may be safer for human use and environmentally friendly when compared to synthetic, non-biodegradable products such as DEET.
- Plants that contain oils reportedly to have repellent activity include citronella, cedar, verbena, pennyroyal, geranium, lavender, pine, cajeput, catnip, cinnamon, rosemary, basil, thyme, allspice, garlic, and

peppermint.

- Although some plant-based repellents have shown effective repellent activity, to date none demonstrate the broad effectiveness and duration of protection of DEET.
- The combination of permethrin-treated clothing and the application of a chemical-based skin repellent should effectively protect against most biting insects, even in areas with high populations of the insect-biting critters.

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Related information

References:

- Katz TM, Miller JH, Hebert AA. Insect repellents: Historical perspectives and new developments. J Am Acad Dermatol 2008;58:865-71. [Medline](#).

On DermNet NZ:

- [Insect bites and stings](#)
- [Denque fever](#)
- [Chikungunya fever](#)
- [Lyme disease](#)

Other websites:

- [Insect repellents](#) - emedicine dermatology, the online textbook

Books about skin diseases:

See the [DermNet NZ bookstore](#)

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DermNet does not provide an on-line consultation service.

If you have any concerns with your skin or its treatment, see a [dermatologist](#) for advice.

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