



STOP	Dengue cases have sky-rocketed this year, with Malaysia seeing a 347% increase from the same time last year [1] and Indonesia having the highest number in ASEAN [15].
STUDY	Dengue is a mosquito-borne infection spread mostly by the <i>Aedes aegypti</i> mosquito. It causes flu-like illness, complications which can kill on average 2.5% of those infected [6].
ACT	There is no specific treatment for dengue, so prevention and control is essential. This includes removing breeding areas and minimising the risk of getting bitten [6].

How do I prevent mosquitos breeding in and around my home?

- To prevent breeding empty or clean once a week any containers that contain water [5]:
 - Roof Gutters - Tyres / Toys - Stagnant Drains - Containers
 - Flower Pots - Sink Dish Tray - Tray under Refrigerator - Air-Con Trays
 - Wading Pools - Indoor Vases - Discarded Bottles/Cans - Cover Pools
- If you must keep open water outside (fountains or water features) regularly add a larvicide (e.g. Temophos) which will kill the mosquito larva in the water before they turn into adults.
- Ensure that insecticide fogging is conducted in your area only when a severe outbreak occurs, only during the early morning and only once or twice a week. Do not use continuously (to prevent resistance), never use inside your home and never use on your skin [24].

What can I do to prevent getting bitten?

- Use an insect repellent on yourself [NOT an insecticide/pesticide]. If you will be outdoors for a short time use a product with lower concentration of repellent [23] (see next section).
- Avoid being outdoors at dawn, dusk and at night when mosquitoes are active.
- Wear loose, light coloured protective clothing when outdoors, mosquitos are attracted to dark colours, cover to your wrists and ankles and wear socks.
- Install insect screens, use mosquito nets over beds and use a fan when you are sleeping.
- Use mosquito nets impregnated with permethrin (a pesticide/insecticide that kills mosquitoes).
- Insecticides contained in sprays, vaporisers, plug-in-mats, etc, can be effective but should be used with caution and in conjunction with other repellents, and **NEVER** on your body [5].
- We could not find any evidence that bug zappers or ultrasonic devices are effective [4] [5].
- Avoid wearing perfume; mosquitos can be attracted to strong scents.
- The best electronic devices to kill mosquitoes in the house are traps – in our target countries you can buy traps that produce CO₂ (via photocatalyst under ultraviolet light) to attract the mosquito and then use a fan to suck the mosquito into the trap [4] [5].
- Also ensure that you keep containers of bug repellent and pesticides/insecticides locked away and out of reach from young children to reduce the chances of accidental poisoning.

What mosquito repellents should I use?

DEET (Diethyl-meta-toluamide) is the most effective mosquito repellent to use in countries with dengue or malaria (like our target countries listed in the header) [2] [3] [5] [12]. Be aware of the fact that DEET can cause skin irritation to people with sensitivity issues, but when used in low level concentrations (<30%) it should not pose a risk. Follow label instructions, as well as the below [2] [3] [5]:

- Test repellent on a small patch of skin before using it on you or your child's skin, if you experience a negative reaction look at using botanical or synthetic repellents (next section).*
- If you are worried about spraying repellent on your child's/babies skin, spray on their clothing*
- Apply only on exposed skin or on top of clothing (not underneath), and wash when finished.



- Do not spray on the face, eyes, ears or on open wounds. For kids don't spray on their hands.
- If you have a reaction, stop using the product. Reapply repellents as required.
- People over 12 years – 30% concentration of DEET, which is effective for **6 hours**. DEET above 30% does not yield better protection, but increases length of effectiveness.
- Children 2 to 12 years – **10% DEET**, applied up to 3 times daily. Effective for **3 hours**.
- Babies 6 months to 2 years – **10% DEET**, no more than once daily. Effective for **3 hours**.
- Under 6 months – Do not use DEET, use nets or stay away from mosquito areas if possible.

Multiple studies [7] [8] [9] [16] [28] show that when instructions and guidelines are followed DEET is **NOT** a health risk (though it may damage some plastics). DEET is 100% effective [10], which is important, as only one mosquito bite can cause dengue! In Malaysia the Drugs Control Authority has set a maximum level of DEET for sale at 20%, and recommended use above age 10 only [14]. None of our other target countries (listed in header) appear to have these restrictions, however Canada limits DEET sales to 30% concentration. The following repellents are less effective compared to DEET [2] [3] [5] [8] [10] [11] [12], but can still be used as a mosquito repellent:

- **Botanical Repellents:**
 - Oil of lemon Eucalyptus can be a good botanical alternative, it can be natural at 10% (OLE) or synthetic at 30-40% (PMD). **NOT** suitable for children under 3 [10].
 - We could not find any peer-reviewed scientific evidence to support the use of any other botanicals as repellents in malaria/dengue areas; including oils of castor, soybean, citronella, neem, cedar, clove, geraniol, lemongrass, peppermint or rosemary [12][19][20].
- **Non-DEET Synthetic Repellents**
 - Picaridin (KBR 3023) – 10-20% suitable for 8 hours. **NOT** suitable for children under 3.
 - IR3535 – 10-20% suitable for 8 hours (may damage plastics).

Summary of Mosquito Repellent Review

Active Ingredient	Available Brands (NOT an endorsement)	Active Conc.	Effective Time (see label to confirm)	Age Limit	Effectiveness (on Aedes mosquitoes)	Approved By [24][25][26][27]	Ref.
DEET	-	23.8%	480 minutes	>12	100% Protection	WHO, EU, CDC, EPA	[9] [10] [16] [22]
	OFF!, Soffell, Auran	13-15%	360 minutes	>12			
	OFF!	7.5%	120-180 minutes	>2			
	-	4.75%	45-120 minutes	>0.5			
Oil of Lemon Eucalyptus	Mozi Guard	32%	180 minutes	>3	95% Protection	EU, CDC, EPA	[10] [12] [9]
	-	10%	120 minutes				
Picaridin	Moskito Guard	20%	480 minutes	>3	95% Protection	CDC, EPA	[2] [3] [9] [12]
	Moz Away Junior	9-10%	240 minutes				
IR3535	Pureen Rekito	20%	240-480 minutes	>1	95% Protection	WHO, EU, CDC, EPA	[9] [16] [18]
	-	7.5%	120 minutes	>0.5			
Citronella	-	12%	1-55 minutes	>3	20-90% Protection	EPA	[5] [16] [10] [19]
Soybean Oil	-	2.0%	90 minutes	>0.5	20-90% Protection	None	[5] [16] [10] [19] [21]

What about other potential Repellents?

We found the following about other potential repellents:

- We could not find any evidence of the effectiveness of repellents contained in patches, battery powered clip-ons (with insecticide) and bands for your wrist, neck or ankles and so do not recommend their use (repellents only protect up to 4 cm from the site of application) [16].
- We have found no evidence that ingestion of garlic or Vitamin B1 provide any repellency [16].
- We also recommend that you don't solely rely on mosquito coils by themselves, as they only provided minimal protection in a 2 metre radius, and only if there is no wind [4] [13].
- Sunscreen or moisturisers combined with repellents are also not recommended [12].



References

- [1] Statistics: http://www.moh.gov.my/index.php/database_stores/store_view_page/17/543
- [2] US Department of Interior (DOI): <http://www.doi.gov/greening/procurement/Deet-Repellent.cfm>
- [3] Mayo Clinic: <http://www.mayoclinic.org/diseases-conditions/mosquito-bites/basics/prevention/con-20032350>
- [4] American Mosquito Control Association (AMCA): <http://www.mosquito.org/fag>
- [5] Health Canada (HC): <http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/life-vie/insect-eng.php>
- [6] The World Health Organisation: <http://www.who.int/topics/dengue/en/>
- [7] BioMed Central: <http://www.biomedcentral.com/presscenter/pressreleases/20140603>
- [8] US EPA: <http://www.epa.gov/pesticides/factsheets/chemicals/deet.htm>
- [9] US EPA Insect Repellent Search: <http://cfpub.epa.gov/oppref/insect/>
- [10] PubMed: <http://www.ncbi.nlm.nih.gov/pubmed/24772681>
- [11] http://www.slate.com/articles/health_and_science/medical_examiner/2013/05/insect_repellents_epa_approval_evaluating_deet_picaridin_lemon_eucalyptus.html
- [12] EWG: <http://www.ewg.org/research/ewgs-guide-bug-repellents/repellent-chemicals>
- [13] CTV News: <http://www.ctvnews.ca/health/repelling-mosquitoes-a-guide-to-what-works-and-what-doesn-t-1.1895243>
- [14] WHO: <http://apps.who.int/medicinedocs/fr/d/Js2255e/1.3.html>
- [15] The Diplomat: <http://thediplomat.com/2014/02/dengue-fever-on-the-rise-in-southeast-asia/>
- [16] New England Journal of Medicine
<http://www.nejm.org/doi/full/10.1056/NEJMoa011699#t=articleMethods>
- [17] Consumer Reports <http://www.consumerreports.org/cro/2014/05/best-way-to-stop-bug-bites/index.htm>
- [18] Merck:
http://www.ir3535.com/product.ir3535.pm/en/images/Efficacy_Report_IR3535_tcm2213_101326.pdf
- [19] Tropical Medicine: <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3156.2011.02781.x/pdf>
- [20] Repellent Review: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059459/>
- [21] Soybean: <http://www.bioone.org/doi/abs/10.4039/n10-032?journalCode=cent>
- [22] Baby Centre: http://www.babycenter.com/0_test-your-health-iq-which-bug-repellents-are-safe-for-your-t_1242550.bc
- [23] Healthy Canadians http://www.healthycanadians.gc.ca/health-sante/environmentenvironnement/pesticides/insect_repellents-insectifuges-eng.php
- [24] WHO Guidelines: http://whqlibdoc.who.int/publications/2009/9789241547871_eng.pdf
- [25] European Chemicals Agency (Search for type 19):
<http://echa.europa.eu/web/quest/information-on-chemicals/biocidal-active-substances>
- [26] CDC: <http://wwwnc.cdc.gov/travel/yellowbook/2014/chapter-2-the-pre-travel-consultation/protection-against-mosquitoes-ticks-and-other-insects-and-arthropods>
- [27] EPA registered chemicals: <http://www2.epa.gov/insect-repellents/skin-applied-repellent-ingredients>
- [28] EPA DEET Summary [The risk of seizures associated with DEET was related to ingestion and incorrect application, and was estimated by the EPA to occur in one per 100 million users - you are significantly more likely to be struck by lightning!]:
http://www.epa.gov/teach/chem_summ/DEET_summary.pdf