

## DEET-based insect repellents: Are they safe?

Michael Tichon<sup>1</sup>, B.Sc. and John Issa<sup>2</sup> ..PhD..

Individuals define "safe" differently. Therefore, "safe" is not an appropriate term. A more appropriate question is "what are the hazards and risks of using (or not using) a DEET-based insect repellent".

**Hazard** is the adverse effect that could occur. Hazard is often determined by exposure to exaggerated (very high) doses of a substance. A common measure of hazard is the LD50 (dose of a chemical required to kill 50% of a test organism). Using LD50 as a measure of hazard we see DEET has an oral LD50 of 2170 to 3664 mg/kg body weight<sup>3</sup>, i.e. for each kilogram bodyweight, it would be ingested about 2 to 3 grams of DEET to kill the test animal (rat). As rats typically weigh about 500 g, a rat would need to ingest about 1 to 1.5 g DEET. A 70 kg person would need to ingest 140 to 210 grams of DEET.

This compares with the theoretical<sup>4</sup> dose that needs to be ingested by a 70 kg person to be fatal:

- Baking soda (LD50 = 4220 mg/kg bw): 500 g.
- Ethyl alcohol (LD50 = 3450 mg/kg bw): 240 g.
- Salt (LD50 = 3000 mg/kg bw): 210 g.
- Eucalyptus oil (LD50 = 2480 mg/kg bw): 168 g.
- Acetic acid (vinegar: LD50 = 2000 mg/kg bw): 140 g.
- Tea tree oil (LD50 = 1900 mg/kg bw): 133 g.
- Caffeine (LD50 = 127 mg/kg bw): 9 g.
- Nicotine (LD50 = 24 mg/kg bw): 1.7 g.

These numbers are indicative. It does not mean it is "safe" for a 70 kg person to ingest 240 g of alcohol. We know there are effects other than immediate death. Impaired ability to drive and liver damage are known adverse effects from short and prolonged exposure to alcohol.

Even though there are adverse effects associated with consumption of alcohol, people still choose to consume alcohol. However, responsible consumption of alcohol is advocated with advertising often recommending that alcoholic beverages be "enjoyed responsibly" or that the suppliers "promote responsible drinking".

"Responsible drinking" is an attempt to minimise the "risks" associated with consuming alcoholic beverages.

**Risk** is the likelihood of harm. It is often expressed as a mathematical function of both the hazard and the exposure. Therefore alcoholic beverages, consumed in moderation, have little risk (due to low exposure). Taken in excess, they pose a significant risk,

---

<sup>1</sup> Principal Consultant, N&F Pty Ltd, P.O. Box 403, Parramatta, NSW 2124 Australia.

<sup>2</sup> Toxicologist and Principal Consultant, Cintox P.O. Box 403, Parramatta, NSW 2124 Australia.

<sup>3</sup> US EPA (1998). Reregistration Eligibility Decision (RED): DEET

<sup>4</sup> The LD50 is not an absolute number. It is a number used for convenience to compare the hazard posed by different substances. Variability between individuals will result in any single individual requiring higher or lower amounts to experience adverse effects than another individual.

including death either directly ("alcohol poisoning") or indirectly (e.g. in a motor vehicle accident) due to increased exposure.

Even water has risks. In a desert, the risk of drowning is low but in the middle of an ocean the risk is high due to the exposure. However, the hazard (drowning) remains the same.

The risk of adults drowning in a bath is low but there is very risk for babies, even though the exposure is the same. Babies and young children need to be supervised around water, even small amounts of water.

### **How does discussion of alcohol and water relate to use of DEET-based insect repellents: Balancing risk against benefits?**

We are all free to not use insect repellents. Many people choose to use insect repellents for various reasons including comfort (prevent being bitten or itching) and health (prevent diseases transmitted by biting insects).

Prevention of bites is not always purely for comfort. People working in hazardous situations may be distracted by biting insects and could sustain injuries or cause other people to be hurt, e.g. if working with electrical installations.

The World Health Organisation estimated that in 2008, malaria, a disease transmitted by mosquitoes, caused nearly one million deaths<sup>5</sup> worldwide. Similarly, Dengue (and Dengue haemorrhagic fever) transmitted by mosquitoes and present in Northern Australia is the leading cause of death and serious illness in children in some Asian countries<sup>6</sup>.

Vector-borne diseases cannot be transmitted to a person if the person is not bitten. Covers (e.g. clothing, mosquito netting) prevent bites. However, where covers are not practical, the use of an effective repellent is often required. In such situations it is necessary to consider the relative risks posed by the pests and by the insect repellent:

- Am I willing to be bitten by biting insects?
- What would happen if I contracted a vector-borne disease? How would this affect me?
- What precautions should I take (e.g. use of a repellent) and what are the risks associated with the repellent?

### **Assessing the risks of insect repellents.**

1. Does the repellent provide the required level of protection? There are a wide variety of insect repellents available. Some are more effective than others. DEET, developed in 1946 by the US Army to protect military personnel operating in insect-infested environments, is considered the standard against which all other insect repellents are compared. Repeated studies have shown DEET-based repellents provide effective, long-term protection from biting insects with higher concentrations of DEET providing longer protection than lower concentrations<sup>7</sup>.
2. Who will use the product (children, adults) and for how long? Long term exposure to responsible use of DEET has been shown to not pose unreasonable

---

<sup>5</sup> See: <http://www.who.int/mediacentre/factsheets/fs094/en/index.html>

<sup>6</sup> See: <http://www.who.int/mediacentre/factsheets/fs117/en/index.html>

<sup>7</sup> Example from published literature: Fradin, MS., Day, J.F. (2002). Comparative efficacy of insect repellents against mosquito bites. *New England Journal of Medicine*. Vol. 347 (1), pages 13-18.

risk<sup>8</sup>. However, there are indications that children (under 12 years) should not use high concentration insect repellents for long periods.

3. Is the product registered? Many countries, including Australia, have regulators that independently assess insect repellents for safety and effectiveness, e.g. in Australia the regulator is the Australian Pesticides and Veterinary Medicines Authority (APVMA). The Therapeutic Goods Authority (TGA) also lists DEET as a substance that can be used in Listed Medicines. Registration of an insect repellent requires these regulatory authorities to review data on the safety of the products. Regulators take conservative approaches using "safety factors" to minimise risk to people using the product. The information that minimises risk is contained in the warnings and use directions on the product label. The effectiveness of these measures is illustrated by use of DEET in the US resulting in a very low number of adverse effects<sup>9</sup>.

In Australia, the APVMA approved label will have an APVMA Approval Number on the label (generally written as APVMA followed by a number). Responsible use requires that the product be used in accordance with the label directions.

### Some myths, misconceptions and other matters.

- DEET melts plastic. It cannot be good for my skin. DEET's ability to melt or soften plastics is not an indicator of effects on humans. There are plenty of other substances that effects on other materials, e.g. eucalyptus oil is an excellent solvent and will also soften certain plastics.
- Natural is safer than synthetic. Some of the most toxic substances are natural. An extract of a plant (Hemlock) was used to kill Socrates. Aflatoxins, produced by certain moulds are extremely potent carcinogens. Lead, arsenic, mercury are well known toxic chemicals. Ingredients within essential oils can cause allergic reactions, irritation and other effects.
- More is better – Wrong! Overuse of substances can have deleterious effects in the same way overuse of alcohol is damaging to the health. Warfarin is a medication prescribed to people with certain heart conditions. It is also a common rat poison. Over used it is lethal. At the right dose it is beneficial. Use products, including personal insect repellents, according to label directions.
- Home made repellents are safer or better. There are numerous substances that are claimed to have insect repellent activity:
  - Dettol®, an antiseptic, is sometimes recommended. There are reports of allergic reactions resulting from undiluted Dettol being applied to skin. The product label does not recommend Dettol be applied to skin undilluted.
  - Vitamin B. We have not been able to find any scientific literature that shows that vitamin B is effective. Fradin and Day (2002)<sup>10</sup> stated "No ingested compound, including garlic and thiamine (vitamin B<sub>1</sub>), has been found to be capable of repelling biting arthropods" (p 17). Similarly, Ives

---

<sup>8</sup> Example from published literature: Antwi, F.B., Shama, L.M., Peterson, R.K.D. (2008). Risk assessments for the insect repellents DEET and picaridin. *Regulatory Toxicology and Pharmacology*. Vol 51, pages 31-36.

<sup>9</sup> Osimita, T.G., Murphy, J.V., Fell, L.A. (2010). Adverse events associated with the use of insect repellents containing N,N-diethyl-m-toluamide (DEET). *Regulatory Toxicology and Pharmacology*. Vol 56, pages 93-99. In this paper the authors reviewed adverse effects resulting from use of DEET based products in the US from 1995 to 2001. The authors determined that "several billion applications of DEET were made by US consumers during the seven years" (p 93).

<sup>10</sup> Fradin, MS., Day, J.F. (2002). Comparative efficacy of insect repellents against mosquito bites. *New England Journal of Medicine*. Vol. 347 (1), pages 13-18.

and Paskewitz (2005)<sup>11</sup> concluded that vitamin supplementation has no effect as an insect repellent.

## Conclusions

1. Use of registered insect repellents in accordance with label directions ensures products do not pose unacceptable risk, i.e. they can be used with confidence.
2. A variety of insect repellents are available. DEET is still considered to be the standard against which all others are judged.
3. The higher the concentration of DEET, the longer the effect.
4. High concentrations of DEET-based insect repellents should not be used on children for prolonged periods. Label directions for use on adults and on children should be followed.

---

<sup>11</sup> Ives, A.R., Paskewitz, S.M. (2005). Testing vitamin B as a home remedy against mosquitoes. *Journal of the American Mosquito Control Association*. Vol 21(2), pages 213-217.