Prevention of Vector Transmitted Diseases With Clove Oil Insect Repellent

Rochel Shapiro BSN, RN*

Duke University School of Nursing, Durham, NC

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Vector repellent is one element in the prevention of vector-borne diseases. Families that neglect protecting their children against vectors risk their children contracting illnesses such as West Nile virus, eastern equine encephalitis, Lyme disease, malaria, dengue hemorrhagic fever, yellow fever, babesiosis, Crimean-Congo hemorrhagic fever, Rocky Mountain spotted fever, Southern tick-associated rash illness, ehrlichiosis, tick-borne relapsing fever, tularemia, and other insect and arthropod related diseases (CDC, 2011). Identification of families at risk includes screening of the underlying basis for reluctance to apply insect repellent. Nurses and physicians can participate in a positive role by assisting families to determine the proper prophylaxis by recommending insect repellent choices that are economical, safe, and easy to use. A holistic alternative might include the suggestion of clove oil in cases where families might have trepidations regarding the use of DEET on children. This article will explore the safety and effectiveness of clove oil and its use as an insect repellent.

Background

THE AMERICAN ACADEMY of Pediatrics (AAP) states that insect repellents containing DEET are most effective in the prevention of ticks (Lyme disease) and mosquitoes (West Nile virus) in children older than 2 months (AAP, 2010). Caregivers of children might consider more natural alternatives for the insect repellent needs of children if highly regarded authorities such as pediatricians, dermatologists, other physicians, and nurses endorsed essential oils, specifically, clove oil, to be used as a safe and effective alternative to DEET, although the AAP reports the safety of DEET (AAP, 2003). These recommendations are in accordance with the Food and Drug Administration (FDA) guidelines (FDA, 2010), which purport the safety of DEET.

The Infectious Diseases and Immunization Committee of the Canadian Paediatric Society (2003) describes research on different insect repellent products as follows: the duration of insect repellency provided by DEET as determined by concentration—23.8% DEET provided 5 hours of protection, 20% was effective for 4 hours, 6.65% remained effective for 2 hours, and 4.54% provided insect repellency for 1.5 hours; soybean oil (2%) mixture protected for 1.5 hours; whereas oil of eucalyptus appeared to provide 2 hours of protection.

Approved insect repellents have met required standards and have been shown not to have complicated adverse reactions on people (CDC, 2010; United States Environmental Protection Agency [EPA], 2009) when used according to label instructions. The improper use of DEET has been associated with neurotoxicity; other side effects noted when using DEET, Citriodiol (p-menthane 3,8-diol [PMD]), Icaridine (KB3023, and 4), and IR3535 include local irritative dermatitis and allergy (Sorge, 2009). Active

* Corresponding author: Rochel Shapiro, BSN, RN.
E-mail address: rochelshapiro@yahoo.com.

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ingredients are those that repel insects (EPA, 2007) in insect repellants and require EPA registration and approval (EPA, 2009). Despite the reported safety of use, parents and caregivers may be leery to apply chemicals to their children’s sensitive skin.

Currently, the list of EPA-approved active ingredients that may be used in insect repellents include the following: DEET 4%–100% strength (N,N-diethyl-meta-toluamide or N,N-diethlyl-3-methyl-benzamide); Picaridin 5%–20% (2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester); oil of lemon eucalyptus 30%–40% (Eucalyptus citriodora/Corymbia citriodora); methyl nonyl ketone; IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester), also called Merck 3535; and oil of citronella. All can be safely applied topically according to directions on product labels (EPA, 2009). Permethrin, allethrin, and metofluthrin can be used on clothing, not directly on skin to repel insects (EPA, 2009).

Essential Oils Boast Insecticidal Properties

Oil of citronella is approved for use on humans as an insect repellent with little or no known toxicity; however, it is known to trigger hypersensitivity-associated dermatological reactions (EPA, 1999). Citronella has been in use since 1948 without adverse incident (EPA, 1999). The mechanism responsible for insect repellency in citronella is the masking of CO2 or lactic acid discharged by humans that attracts mosquitoes and other insects. Citronella is found on the list of chemicals that may not require EPA registration in some cases. Unless a product containing citronella is EPA registered, it has not been subject to EPA review and the EPA cannot corroborate its safety and effectiveness. Oil of citronella goods are often marketed as repellent candles, although topical preparations offer insect defense as well (EPA, 2009).

Oil of lemon eucalyptus (active ingredient: PMD) was discovered to provide insect defense comparable to low concentrations of DEET (EPA, 2009; CDC, 2010).

DEET has been the gold standard of insect repellency for 60 years, but natural products such as oil of lemon eucalyptus are entering the market with proven efficacy and high patient satisfaction (Katz, Miller, & Herbert, 2008); despite the promising research, natural products are not commonly recommended. Natural products such as essential oils proven to provide effective and environmentally safe insect control have been extensively tested and offer safer human health alternatives to insect control with synthetic chemicals (Nerio, Olivero-Verbel, & Stashenko, 2010). Numerous plant essential oils interfere with the octopaminergic nervous system in insects, which is not shared with mammals, and provide a comparatively nontoxic and safer alternative to pest control for mammals and fish (Koul, Walai, & Dhaliwal, 2008). Eugenol is a natural chemical found in oil of cloves that attracts Japanese beetles, kills insects, and is considered safe and without risks when used as directed (EPA, 2004).

Clove Oil Applications

Clove and clove oil are both EPA classified as minimum risk pesticides and are not subject to federal registration requirements because their active and inert ingredients are evidently safe for use on people and are exempt from federal registration under section 25(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; EPA, 2011b). By not falling under the guidelines requiring FIFRA registration, the EPA is unable to endorse safety and effectiveness (EPA, 2009). However, the FDA’s Select Committee on Generally Recognized as Safe Substances (GRAS) evaluated and classified clove oil to be GRAS (FDA, 2009b).

Various natural products are formulated with clove oil and are marketed as over-the-counter natural products and cosmetics. In an antimicrobial study, clove oil in combination with other substances including arrowroot, baking soda, basil oil, bay oil, tea tree oil, and sage oil has been topically applied to the feet (Misner, 2007); cutaneous hypersensitivity reactions were not noted. Essential oils can cause skin irritation in some people, whereas others might find the aroma offensive (Barnard, 1999). Skin irritation is not an unusual complaint in a topically applied product and has been reported with the use of DEET, Citriodiol (PMD), Icaridine (KB3023, and 4), and IR3535 (Sorge, 2009). Clove oil (50%) blended with 50% geranium oil, or 50% thyme oil, was proven highly efficacious as a topical mosquito repellent but may produce cutaneous irritation (Barnard, 1999), which may be the result of the higher concentration of the essential oil against the skin. Medline (2011, para 11) reports, “In lab and field tests, undiluted clove oil repelled multiple species of mosquitoes for up to two hours. However, undiluted clove oil may also cause skin rash in sensitive people.”

Clove oil has been studied for its antibacterial, antimicrobial, and antifungal properties against cutaneous infectious manifestations and has been shown to be environmentally safe and nontoxic to humans for use in medicine, perfume, and food flavoring (Trongtokit, Rongsriyam, Komalamisra, & Apiwathnasorn, 2005). Chaieb et al. (2007) describe clove oil to encompass antibacterial, antiviral, antimicrobial, antifungal, anti-inflammatory, cytotoxic, insect repellency, anesthetic, and antitumor properties. Katritzky et al. (2008, p. 7362) report, “We identified 23 compounds for synthesis and study that we expected to be as efficacious as DEET... Astonishingly, a number of these protected (more than) 3 times as long as DEET.” Researchers Trongtokit et al. (2005) studied the mosquito repellency of 38 essential oils and found clove oil (Syzygium aromaticum) to provide the longest and most effective protection against three mosquito species; mosquito defense lasted between 2 and 4 hours. Clove oil...
(S aromaticum) and thyme oil were both found to be very effective essential oils to repel mosquitoes (Barnard, 1999). Clove oil is a potent antifungal agent (Nozaki, Takahashi, Okamoto, Ito, & Hatano, 2010). Clove oil was found to repel lice (Yang, Lee, Clark, & Ahn, 2004). Clove oil (S aromaticum) is commonly used in Thailand as a food flavoring and to treat dental caries (Trongtokit, Rongsrivam, Komalamisra, Krisadphong, & Apiwathnasom, 2004). Clove oil is an effective insect repellent (Barnard, 1999). Dayan, Cantrell, and Duke (2009) report that clove oil is a rapidly acting insecticide that is effective on arthropod pests, armyworms, thrips, aphids, and mites. Clove oil is used in organic agriculture as an alternative to nonorganic farming methods. Because clove oil is considered a biopesticide, it is believed to be safer than chemical pesticides (EPA, 2011a). Clove oil is a minimum-risk pesticide (EPA, 2011b). Acaricidal properties (destroys mites and ticks) were found in clove oil (Kim, Kim, Choi, & Ahn, 2003). Saad, Hussien, Sahe, and Ahmed (2006) researched the acaricidal action of 14 essential oils and determined clove oil as the most effective acaricide against household dust mites: This study suggested that clove oil may be an ingredient to consider when shampooing carpets as an aid to mite control.

Endorsement is needed from respected authorities such as the AAP. Health care professionals might be able to suggest natural clove oil as an alternative to the currently recommended insect repellent DEET for the insect repellent needs of their patients.

**Research Questions: Clove Oil as an Insect Repellent**

Trongtokit et al. (2004) tested experimental topical gels and creams containing clove oil developed to determine strength and duration of efficacy against various mosquito species. They concluded that 10% clove oil combined with 10% makaen oil provided complete protection for 4 hours after application, and 95.7% repellency protection 5 hours following topical application to the volunteers’ legs. Additional strengths were tested resulting in a suggestion that these preparations can be used to provide mosquito repellency.

Further research may be needed to determine the strength, duration of effectiveness, proper application, recommended age to insure safe application, dermatological tolerance, and optimum vehicle for safe dermatological application of clove oil. However, there are clove oil products currently marketed and in use as over-the-counter preparations. Currently, more research is needed to determine the percent strength of clove oil necessary to promote effective insect repellency and to take this strength and immerse it into a neutral vehicle to test for cutaneous reactions. Testing would also be needed to determine the length of time that the preparation of this composition remains active. Additional research is needed to investigate the side effects of irritation to the eyes and other mucous membranes and to determine if the risks outweigh the benefit of using a natural preparation versus a chemical insect repellent. In addition to determining parameters for a topical application and the vehicle to ensure cutaneous nonirritability, other mechanisms to explore would include non-aerosol multipurpose sprays (those that can be sprayed onto both skin and clothing) and ways to impregnate fabric such as tents and mosquito netting with clove oil.

**Conclusions**

Clove oil has had success when topically applied for its antimicrobial, antibacterial, and antiseptic properties against infections and as a vermifuge (antiworm) (Mesbah, Mourad & Rokaia, 2006). Clove oil is commonly used in dental root canal surgery for its antimicrobial properties (Trongtokit et al., 2004) but has not gained much support for use as an insect repellent. This might be because skepticism is associated with clove oil because it is a natural product in the public domain and might be regarded as less potent or effective than DEET or because clove oil is not endorsed by respected authorities such as the AAP and dermatology associations. DEET is currently recommended by the AAP (2010), EPA (2007), and CDC (2010) for its insect-repelling properties.

Nurses and physicians are in a unique position to assist families with questions related to the choices of insect repellent. The physician and nurse’s primary motivation in this venue is to promote health and prevent vector-borne illness. Interventions will include assessment of familial, social, economic, political, and religious needs of patients and their families. Nurses and physicians might offer holistic approaches such as clove oil instead of DEET if these alternatives are promoted by recognized authorities and backed by evidenced-based research. In this way, nurses and physicians might help protect their patients and families from such vector-contracted illnesses as West Nile virus, eastern equine encephalitis, Lyme disease, malaria, dengue fever, yellow fever, babesiosis, Crimean-Congo hemorrhagic fever, Rocky Mountain spotted fever, Southern tick-associated rash illness, ehrlichiosis, tick-borne relapsing fever, and tularemia (CDC, 2011). Although it is important to determine reasons for avoidance of chemical prophylaxis to prevent insect bites and stings, nurses and physicians ought to be able to suggest safe, feasible, natural, and evidenced-based insect repellent alternatives.

**References**


