

The Effectiveness of Citronella Products against Mosquito Bites: A Systematic Review



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Introduction



- Mosquitoes-transmitted disease remains a major source of illness and death worldwide
- Mosquitoes alone transmit diseases to more than 700 million people per year*
- More than 2.5 billion people in tropical and subtropical climates have higher risk of mosquitoes-borne diseases, such as malaria, dengue hemorrhagic fever, and several forms of encephalitis**

* World Health Organization

* * The Centers for Disease Control and Prevention

Introduction



- Mosquito control and personal protection from mosquitos are currently the most important means to control mosquito bites
- Repellents are one of the most effective measures
 - DEET (N,N -diethyl-3-methylbenzamide) is a synthetic chemical repellent
 - Excellent repellency
 - Adverse effects are concerned
 - Varied from mild to severe, such as contact dermatitis, generalized angioedema, and seizures in children*
- The use of plant-derived agents is increasing

Introduction



- Citronella oil is the most popular “**Natural**” insect repellent in Thailand
- Registered for this use from US Environmental Protection Agency (EPA) since 1948
- Citronella oil has **little or no toxicity** when used as a topical insect repellent
 - No reports of adverse effects
- Supporting evidence of the effectiveness of citronella products compared to DEET are lacking



Objective



- To determine the effectiveness of citronella products as the mosquito repellent

Method



- Systematic review
- Multiple computerized databases
 - PUBMED, EMBASE, Cochrane CENTRAL, CINAHL, AMED and medicinal Plant Database
- All articles were independently reviewed by 2 investigators



Inclusion criteria

- Compared citronella products to DEET in human volunteer
- Conducted in a controlled laboratory environment which can be...
 - The arm exposure cage test*
 - The walk-in exposure room test

Outcome Measurement



- **Protection time***

The elapsed time between repellents application and the first bites

- **% Repellency****

$$\frac{(C-T) \times 100}{C}$$

C = no. mosquito in control areas

T = no. mosquito in treatment areas

Statistical Analyses



- The difference of the protection time for mosquito bites between citronella products and DEET group was an outcome measure used for statistical pooling
- Using the DerSimonian and Laird method under a random-effects model.
- Heterogeneity test was performed using the Cochran-Mantel-Haenszel Method
- Data manipulation and statistical analyses were performed using STATA software

Results



Studies identified from retrieval
(n= 161)

Studies excluded because they were not
conducted in human (n=35)

Studies retrieved for detailed
evaluation (n=126)

Studies excluded because they were not
conducted in controlled environment (n=94),
they were duplicated articles (n=4),
and they were not control trial (n=20)

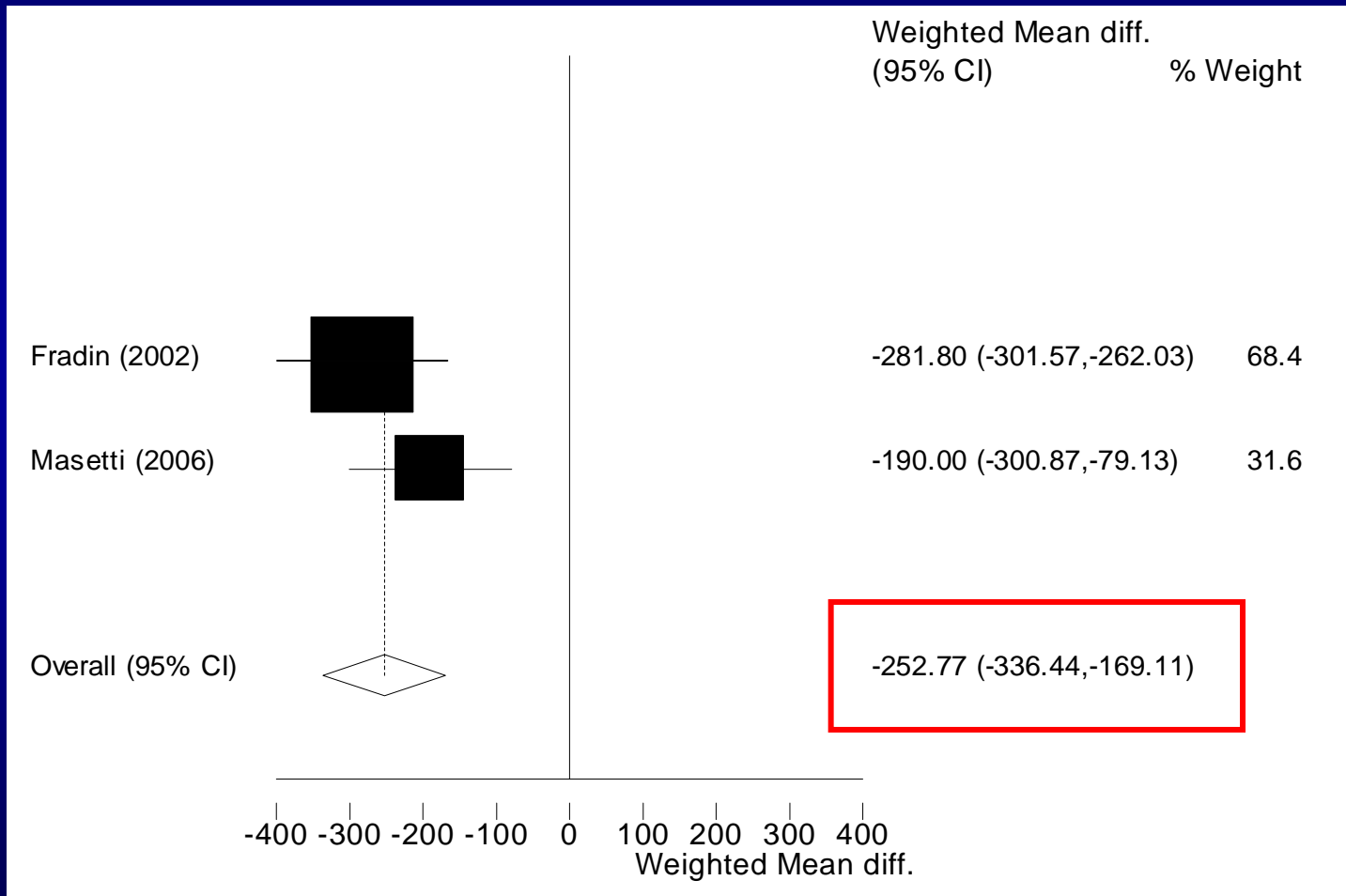
Studies meeting inclusion
criteria (n=9)

Results



- Citronella products were different in several aspects including dosage form, concentration and preparation methods
- In 7 studies using cage method
 - Only 2 studies using mean protection time as the outcome were included in the meta-analysis
- Based on results of the 2 studies
 - Protection time in the citronella group was consistently **shorter than** DEET group [253 minutes (95% CI: 336-169)]

Results



Results



- In 2 studies employing room method
 - 25-40% Citronella and 50% DEET
 - For *Aedes spp* and *Culex spp*
 - 100% repellency for 6 hours
 - For *Anopheles spp.*
 - 100% repellency for 9 hours in the citronella group
 - 100% repellency for 12 hours in the DEET group

Discussion



- This study included only the studies that performed in controlled laboratory environment
 - The effectiveness of the products could be different in the usual environment
- The included studies were different in several aspects
- None of the included studies reported safety of citronella product

Conclusion



- Citronella product is less effective than DEET against mosquito bites
- The repellent efficacy and duration of protection vary considerably among citronella products and mosquito species
- Further studies are needed to identify appropriate concentration of citronella product for effective protection from mosquito bites

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Thank you
& Question ?

Backup slide

The arm exposure cage test¹



- The treated arm was exposed for minute to 30 female mosquitoes, in a cage, and any mosquitoes biting were counted
- Every 30 minutes after treatment the treated arm was re-exposed to mosquitoes.

Field study



- According to the Environmental Protection Agency (EPA), the only meaningful way to measure the efficacy of an insect repellent is to test it under realistic conditions.
- It would have been impossible to conduct a valid comparative field study of this size, given the multiple environmental variables that affect biting rates
- The ethics of requiring field trials may need to be examined by the EPA, which has not yet adopted the recommendations of the panel.

DEET

- The maximum conc of DEET allowed to use and proved to be safe is 50%, higher conc does not increase efficacy, but adverse events are reported
- Different designs of study method make it difficult to compare the effectiveness of each agent

Active ingredient



citronellal

Eucalyptol

Citral

Linalol

Eugenol

Camphor