


There are a number of similarities in the issues between the use of 'green' pesticides for the control of two obligate blood feeders: ticks and bed bugs


REVIEW OF THE "NATURAL" PRODUCT MINEFIELD FOR BED BUG CONTROL

Kirby C. Stafford III, Ph.D.
 Chief Scientist, State Entomologist
 Department of Entomology
 Center for Vector Biology & Zoonotic Diseases
 Connecticut Agricultural Experiment Station
 New Haven, CT




Bed Bug Treatments and 25b Compounds

- Pest management professional (PMP) applied EPA-registered synthetic acaricides or insecticides continues to be the primary and most efficacious method of bed bug and tick control for homeowners with increasing interest in "green" products, botanically-based or other all "natural" products for controlling pests. The big question is are they effective under natural conditions?
- Increased interest by companies as products can be exempt from registration under minimum risk exemption regulations. Quick to market vs 10 years from lab bench to registered and marketed product.
- Many homeowners self treat for bed bugs with a glut of unregulated, off the shelf, internet available products. Some PMPs use 25b materials for organic tick control. Some 25b products do have EPA registration numbers.
- The internet is all too often an easy source of misinformation, directing those who have or think they have bed bugs to prevention methods that are ineffective and potentially harmful, underscoring the need for improving science-based tick-borne disease prevention communication.
- Misuse or poor application can result in poor bed bug control and deleterious health consequences (for example, toxic human exposures to pesticides).




EPA registered products mainly pyrethroids, neonictinoids, etc.



Examples – 370 products listed for bed bugs for CT on Kelly Solutions

- CrossFire – clothianidin + metofluthrin + piperonyl butoxide
- Temprid SC – imidacloprid + β -cyfluthrin
- Suspend SC – deltamethrin
- Demand CD – λ -cyhalothrin

Interest in alternatives due to resistance or tolerance to pyrethroids by bed bugs and increased demand by the public for "green" products



EPA Minimum Risk (25b)

What are 25b Compounds?

Also listed whether for non-food or food use

Active Ingredient (examples)	Inert Ingredient (examples)
<ul style="list-style-type: none"> • Cedarwood oil • Cinnamon • Citric acid • Citronella • Eugenol • Garlic & garlic oil • Geraniol • Lauryl sulfate • Lemongrass oil • Peppermint & peppermint oil • Rosemary & rosemary oil • Sesame & sesame oil • Sodium chloride • Sodium lauryl sulfate • Thyme & thyme oil 	<ul style="list-style-type: none"> • Almond hulls, oil, shells • Beeswax • Bentonite • Calcium citrate • Cellulose • Coffee grounds • Diatomaceous earth • Fish meal & oil • Gum arabic • Isopropyl alcohol • Lanolin • Linseed oil • Milk • Mineral oil • Silica, amorphous • Silica gel • Urea • Wintergreen oil

CAES

Look at an EPA registered product

Diatomaceous earth & silica on EPA's minimum risk inert list, but not on minimum risk active ingredient list, hence EPA registration
Would not qualify as a wholly 25b product;
Other ingredients do not have to be listed

KEEP OUT OF REACH OF CHILDREN

CAUTION

PRECAUTIONARY STATEMENTS
Hazard to Humans and Domestic Animals: CAUTION Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, using tobacco or using the toilet.
Prevent: If on eyes, flush eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses if present after the first few minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
EPA Reg. No. 75071-D
EPA Est. No. 75071-MD-1

Net Contents: 4 oz, 5 lbs

Active Ingredient: Silicon Dioxide as Amorphous Silica... 85.1%
Other Ingredients: ... 14.9%
Total: 100%

CAES

Journal of Insect Science (2019) 19:1–2
doi:10.1007/s10841-018-0060-6
Letter to the Editor

ACCEPTED

Harmful Effects of Bed Bug-Killing Method of Diatomaceous Earth on Human Health

Mohammed Akhoundi,^{1,2*} Chloéline Bruel,² and Aneski Iani¹

¹Parasitology Mycology Department, Assistance Hospital, AP-HP, 105, route de St-Denis, 93000 Bobigny Cedex, France, ²Agence Régionale de Santé (ARS) Île-de-France, 36, rue de la Gare, 93000 Paris Cedex 19, France, and *Corresponding author, e-mail: m.akhoundi@aphp.fr

Editorial Office: Public Health

Received 16 July 2018; Editorial Decision 17 August 2018


- Diatomaceous earth dust is a non-chemical method using insecticides composed of amorphous silicon dioxide, **harmful to human health by inhalation**.
- Silica, amorphous, fumed (crystalline free), precipitate, and gel are on minimum risk inert ingredient list; not the active ingredient list so can't be used as wholly 25b product.
- Risks with inhaled products with repeated exposure include silicosis, lung cancer, and nonmalignant respiratory disease (particularly if material contains high percentage of crystalline silica).
- Tolerance to silica-based desiccant dusts has been reported for bed bugs.

Note: Behavioral responses of bed bugs to insecticide dusts could influence their efficacy; bed bugs avoid some insecticide dusts, but some also can provide rapid killing effect with brief contact.

 CAES
The Department of Agricultural Sciences and Entomology, University of California, Davis

A minimum risk product must meet the six conditions listed below. A product that meets all of these six conditions then is exempted from regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), i.e., the pesticide product does not need to be registered with EPA. However, [states may require registration under state laws](#).


- **Condition 1:** The product's active ingredients must only be those that are listed in 40 CFR 152.25(f)(1).
- **Condition 2:** The product's inert ingredients may only be those that have been classified by EPA as:
 - Listed in 40 CFR 152.25(f)(2)
 - commonly consumed food commodities, animal feed items, and edible fats and oils as described in 40 CFR 180.950(a), (b), and (c); and
 - certain chemical substances listed under 40 CFR 180.950(e).
- **Condition 3:** All of the ingredients (both active and inert) must be listed on the label. The active ingredient(s) must be listed by label display name and percentage by weight. Each inert ingredient must be listed by label display name.
- **Condition 4:** The product must not bear claims either to control or mitigate organisms that pose a threat to human health, or insects or rodents carrying specific diseases.
- **Condition 5:** The name of the producer or the company for whom the product was produced and the company's contact information must be displayed prominently on the product label.
- **Condition 6:** The label cannot include any false or misleading statements.

 CAES
The Department of Agricultural Sciences and Entomology, University of California, Davis

Condition 3: Ingredients Listed on Label

- All of the ingredients in an exempted product (both active and inert) must be listed on the label:
- All active ingredients must be listed by label display name* and percentage (by weight).
- All inert ingredients must be listed by label display name*.

*Pursuant to the final rule published on [December 28, 2015](#), the compliance date for the requirement to label ingredients with a label display name is February 26, 2019.

 CAES
The Department of Agricultural Sciences and Entomology, University of California, Davis

Condition 4: Health-Related Claims

- The label cannot state or imply that the product can or will control or reduce organisms that pose a threat to human health, or insects or rodents carrying specific diseases.
- **Claims Linking Pest to Specific Diseases**
- Minimum risk pesticide labels may not bear claims to control rodent, insect or microbial pests in a way that links the pests with any specific disease. The label claim may only be for the pest, as a pest, and not as a disease vector. For example:
- The label may not say:
 - "controls ticks that carry Lyme disease;" or
 - "controls mosquitoes that can transmit malaria, encephalitis, West Nile virus or the Zika virus."
- But can say:
 - "controls ticks;" or
 - "controls mosquitoes."

Bed bugs fall through the cracks [pun intended] on claims, don't transmit any disease pathogens, but can be a health issue.



Condition 6: Label Statements

The label cannot include any false or misleading statements, as described in 40 CFR 170.10(a)(2)(i) through (vii).

Examples of Label Statements that can be False or Misleading

- Statements concerning the composition of the product.
- Example: "Chemical Free"
- Minimum risk pesticide products are composed of chemicals that are listed on the product label.
- The use of the term "chemical free" may be an attempt to convey that the product does not pose risk. However, the use of such a claim is not based on facts and may be considered false or misleading.
- Consumers could misinterpret such a claim to be a safety claim.

Misleading Label Statement

Many websites offer testimonials and endorsements from satisfied customers.

- As an example of a potentially problematic endorsement, the picture of a health professional (white coat and stethoscope) next to an endorsement could cause a consumer to believe that the product is endorsed by the medical establishment.
- Such claims should be accompanied by name, affiliation, and credentials of the expert making the endorsement, so consumers have the ability to judge the relevance of the claim.

Detergent & surfactant 3.0%
Salt 1.0%
Citric Acid 0.2%
(for comparison citric acid makes up to 8% of dry wt. of lemons and limes)
Ingredients technically correct, but....

EFFECTIVE

- With Active Ingredient, Spot
- Supported by Leading Pest Management
- Strongest Active Ingredient
- Premium Quality

A diversity of products can be found on the shelf; most EPA registered, but some not. What is available over the internet for self-treatment is a real concern.

And labels can be more than just false or misleading, but really illegal! Federal agencies like the FDA, USDA, and EPA take a really dim view of use of their logos.

State Requirements for CT

- Commercial use - 25b products same as EPA registered products (must be state registered).
- The same rules apply for commercial applications of these products. The products must have state registration, commercial applicators must be licensed and business registered, they must pre-notify registered abutters, they must post outdoor treatments, they must maintain records of applications.
- No essential oil-based products for bed bugs found registered in CT on Kelly Solutions (just silicon dioxide products like CimeXa, n = 28 products, last updated 1/13/19).



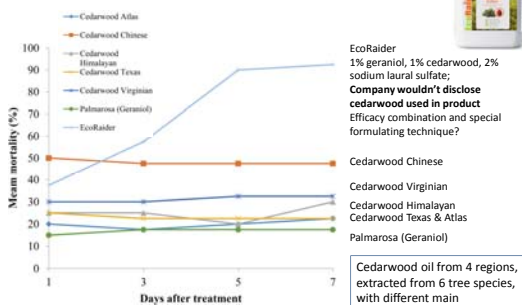
Essential Oils

- Derived from various aromatic plants that are composed of complex mixtures of chemicals
- Composed of different functional groups: phenols, aldehydes, acids, hydrocarbons, terpenoids, etc.
- For example, cedarwood oil can come from diversity of tree species from different genera and localities with different chemical components.
- Concentrations of essential oils in products very low and “unlikely to be lethal to bed bugs when used alone”“Other factors besides the active ingredients must have accounted for the high efficacy of some essential oil-based pesticides.”
Singh et al. 2014. J. Econ. Entomol. 107(6):2163-2170.



Screen of Essential Oils Against Bed Bugs

Zha et al. (2018) Environ. Ent. 111:170-177



Note: these results are from a topical bioassay



SCIENTIFIC REPORTS


OPEN Access Toxicity and neurophysiological impacts of plant essential oil components on bed bugs (Cimicidae: Hemiptera)

Gaire et al. (2019) Sci. Reports. 9:3961

Essential oil component	LD ₅₀ ug/mg body weight (95% limits)
Carvacrol	27.5 (25-30.5)
Thymol	32.5 (29.5-35)
Geraniol	ND (<30% mortality, LC ₅₀ not determinable)
Bifenthrin (positive control)	0.000345 (~72,000 times more potent)

“More than a dozen [dozens!] essential oil-based products are available commercially for indoor use, but only two products have been found effective for bed bug control....Therefore need for conducting comparative baseline toxicity studies...using major components or constituents of different plant essential oils.”

“Carvacrol and thymol were the most active compounds in *topical application bioassays* [italics added]...are not present in any of the essential oil-based products available for bed bug control.”




Original article


In-vitro efficacy of a botanical acaricide and its active ingredients against larvae of susceptible and acaricide-resistant strains of *Rhipicephalus (Rhipiphilus) microplus* Canestrini (Acari: Ixodidae)

Nikhil K. Singh^{1*}, Robert J. Miller^{2*}, Guilherme M. Klafke^{3*}, John A. Godby⁴, Donald B. Thomas⁵, Adalberto A. Pinz de Leon⁶

Ticks & Tick-borne Diseases. 2018. 9:201-206




- Essentria IC-3 active ingredients: 10% rosemary oil, 5% geraniol, 2% peppermint oil
- Other ingredients: Wintergreen Oil, White Mineral Oil, Vanillin, Polyglyceryl Oleate
- Blocks octopamine, a neurotransmitter, neurohormone or neuromodulator in invertebrates
- Larval packet tests multiple strains *R. microplus*
- Among AI's, only geraniol exhibited larvicidal properties (no activity bed bugs)
- Rosemary oil and peppermint oil failed dose- mortality response
- **High response to commercial product attributed to synergism among the principal ingredients and other components present in the product**



Summary Issues “Natural” Products

- No or limited efficacy data, *especially under real world field conditions* (most published studies are topical bioassays).
- Exempted from testing for toxicity, some may be toxic at higher doses, irritants, or allergens.
- Variable composition of essential oils depending on source plant species (may or may not be known or released by manufacturer), extraction method, etc.
- Volatility and lack of persistence, requiring frequent applications.
- Efficacy oil vs. specific components of the plant extract or oil Laboratory (topical, direct spray) vs. field evaluations (i.e., residual activity - bed bugs in cracks, crevices, etc.; ticks under leaf litter).
- **Formulation may make a huge difference because any activity likely due to synergism or interaction of multiple ingredients.**



**From red-bugs and bed-bugs,
from sand-flies and land-flies,
Mosquitoes, gallinippers and fleas,
From hog-ticks and dog-ticks,
from hen-lice and men-lice,
We pray thee, good Lord, give us ease.
An old prayer, circa 1856**

Contact Information:
Kirby C. Stafford III, Ph.D.
CT Agricultural Experiment Station
123 Huntington Street-Box 1106, New Haven, CT 06504
Ph: (203) 974-8485; Email: Kirby.Stafford@ct.gov