Potential of antifungal and antitermitic activity of several essential oils

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Use in traditional practices dating back at least 150 years

- Protection of stored commodities or to repel pests from human habitation (Clausen et al, 2008; Skandamis, P et al, 2002).
- Cosmetic Industry.
- Food industry, flavoring.
- Pharmaceutical industry. (Cogne, 2002);
Properties attributed to essential oils

- Antiseptic
- Antibacterial
- Antifungal
- Antihistamine
- Anti-inflammatory
- Antipruritic
- Antitussive
- Antiviral
- Antiemetic
- Deodorant
- Diuretic
- Immunostimulant
- Repels insects
- Improve sleep
- Kills parasite
Essential oils are the product of secondary metabolites from vegetative plants.

- Obtained from the volatile fraction by steam distillation.

- Complex mixture of monoterpenes and sesquiterpenes with several functional group
ESSENTIAL OILS

- Present in about 50 botanical families.

- Located in flowers, leaves, barks, wood, seeds, fruits, rhyzomes, needles, resins...

- Chemical profiles are affected by climate, soil and yearly growing conditions, environmental conditions...
ECOLOGICAL ROLE

Essential oils

Communication

Defense

Reproduction
Challenge and motivation

Renewable resource

Need of environmentally friendly fungitoxic and insecticidal chemicals

More favourable ecotoxicological and toxicological profile

There is a niche market 1 billion $ world: fungicide 20%; insecticide 27%.
OBJECTIVE

- Identify essential oils with desirable effect on termites and fungi.

- Propose a formulation with essentials oil, with or without classical biocides active against termites and fungi.
SELECTED ESSENTIAL OILS

- Dill (Anethum graveolens)
- Celery (Apium graveolens)
- Tagete (Tageta bipinata)
- Catnip (Nepeta cataria)
- Mint (Mentha piperita)
- Oregano (Origanum vulgare)
- Basil (Ocimum basilicum)
- Marjoram (Origanum majorana)
- Rosemary camphored (Rosmarinus officinalis V)
- Rosemary verbenone (Rosmarinus officinalis C)
SELECTED ESSENTIAL OILS

Savory (*Satureia montana*)
Sage (*Salvia sclarea*)
Lavander (*Lavendula latifolia*)
Thyme (*Thymus vulgaris*)
Lemon (*Citrus limonum*)
Citronnella (*Cymbopogon winterianus*)
Lemongrass (*Cymbopogon citrates*)
Vetiver (*Vetiveria zizanoides*)
Geranium (*Pelargonium graveolens*)
LIST OF ESSENTIAL OILS

Tea tree (Melaleuca alternifolia) - Myrtaceae
Clove (Eugenia caryophillus) - Myrtaceae
Eucalyptus (Eucalyptus globulus) - Myrtaceae
Eucalyptus (Eucalyptus globulus) - Myrtaceae
Cinnamon (Cinnamomum cassia) - Lauraceae
METHODOLOGY

24 essential oils

Dilution (1% to 10%)

No choice test
Reticulitermes santonensis

30 termites / treated paper
METHODOLOGY

24 essential oils

Dilution

No choice test
Reticulitermes santonensis

Mortality rate
Consumption rate
RESULTS

**Group I:** threshold < 1% (v/v)

- Savory (Lamiaceae) died after 1 day exposure

**Group II:** threshold between 1 - 5% (v/v)

- Clove (Myrtaceae) died after 1 day exposure
RESULTS

**Group III:** threshold between 5 % - 10 % (v/v)

- Geranium *(Geraniaceae)*
- Lemongrass *(Poaceae)*
- Mint *(Lamiaceae)*
- Oregano *(Lamiaceae)*

Repellent

Died after 1 or 2 days exposure
RESULTS

Group IV: threshold > 10 % (v/v)

- Cinnamon (Lauraceae)
- Dill (Lamiaceae)
- Thyme (Lamiaceae)
RESULTS

Group V: at 100 % (v/v)

Rosemary C (Lamiaceae)
Celery (Apiceae)

Antifeedent
CONCLUSION

- Essential oils with oxygenated monoterpenes particularly phenolic compounds are more toxic against workers: savory, clove, oregano, lemongrass, mint, thyme.

- The activity is also the result of the synergetic effect with other components (monoterpene hydrocarbone).
Development of a formula

- Development of formula in aqueous phase

  Mixture of essential oils: 11 oils (3 to 8 % v/v)

  + Adjuvants

  + Water
Assessment of the formulations

- **Formulation 1** = mixture of essential oils (3 - 8 % v/v);

- **Formulation 2** = mixture of essential oils (3 - 8 % v/v);
  + 1 biocide;

- **Formulation 3** = mixture of essential oils (3 - 8 % v/v)
  + combination of two biocides.
Standardised tests: NF EN 118

1) Treatment and drying

2) Leaching procedure (EN 84) or not

3) Exposure to termites (8 weeks, 27°C - 70% HR)
Standardised tests: NF EN 118

250 workers
*Reticulitermes santonensis*

Assessment

- Mortality rate
- Visual rating of the exposed sample

0 = no attack; 4 strongly attack
## Results

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<thead>
<tr>
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<th>Without leaching</th>
<th>With leaching (EN 84)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mortality rate</td>
<td>Cotation</td>
</tr>
<tr>
<td>Control</td>
<td>0</td>
<td>4</td>
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<tr>
<td>HE</td>
<td>100</td>
<td>3.7</td>
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<td>He + 1 biocide</td>
<td>100</td>
<td>0</td>
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- Without leaching, the formulae with biocide showed an efficient activity against termites.

- The use of essential oils allowed to decrease the content of classical biocide.
CONCLUSION

- After leaching procedure (EN 84) → loss of effectiveness.

- It is necessary to add additives which will allow the fixation of the compounds.

→ Hasard Class 1 (indoor applications)
Antifungal tests

24 essential oils

Dilution

Antifungal index (AI)

$AI = 0 \quad \text{no activity}$
$AI = 100 \quad \text{activity}$

Coriolus versicolor
Poria Placenta
RESULTS

*Group I*: threshold <0.05% (v/v)

*Cinnamon (Lauraceae)*

Fungicidal

<table>
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<tr>
<th>Mycelium on treated plate</th>
<th>Mycelium on no treated plate</th>
<th>28</th>
</tr>
</thead>
</table>
RESULTS

**Group II**: threshold between 0.05 – 0.1% (v/v)

- Geranium
- Lemongrass
- Catnip

- Thyme
- Savory
- Oregano

**Fungicidal**

**Fungistatic**
RESULTS

Group III: threshold between 0.1 - 0.2% (v/v)

Clove
Citronnellal

Fungicidal
RESULTS

**Group IV**: threshold between 0.2 - 1%

- Mint
- Marjoram
- Lavender
- Tea tree
- Sage
- Verbenone
- Rosemary
- Fungicidal
CONCLUSION

- Essential oils with oxygenated monoterpenes particularly phenolic compounds are more toxic against fungi: cinnamon, geranium, lemongrass, catnip, clove, citronnellal.

- The activity is also the result of the synergetic effect with other components (monoterpenes hydrocarbone).

- We are waiting for the results of EN 113
THANK YOU FOR YOUR ATTENTION

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