Mites in Semi-moist Pet Foods: Strategies to Prevent Infestation

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The Stored-Product "Ecosystem"

Stored Products are Durable Postharvest Agriculture Products
(Durable = Does not require refrigeration)
Tryophagus putrescentiae

- Ham mite, cheese mite, mold mite, copra mite
- Prefers food 15-45% mc, high fat and protein; RH of 70%
- Females lay 3-8 eggs/day, develop in 11 days, live weeks to months
- Mites can be found in all human habitations; part of house-dust mite complex
- Food processing spaces can facilitate very successful mite populations!
Grain Mites: Not Insects!
Arachnids—Spiders and Mites

Body plan: 8 legs, 2 body sections, no wings

Semi-moist pet foods: 15-45% moisture content
Integrated Pest Management for Mites

• Prevention
  – Food-safe chemicals in recipe to deter mites
  – Thorough, effective and consistent cleaning
  – Pesticide sprays of processing and storage areas

• Monitoring
  – Traps to detect and monitor mites over space and time
  – Inspect work spaces and product
  – Monitor customer complaints

• Controls
  – Spot controls (clean and spray) small areas
  – Fumigate/treat entire structure if needed
Semi-Moist Pet Foods and Mites: A Brief History

• Mites became pests of semi-moist pet foods from their inception in the 1960s; the problem was glycerol used as a humectant.

• Some food preservatives and humectants other than glycerol could prevent mite infestations of pet foods.

• All additives were established as “GRAS” compounds: Generally Recognized As Safe.
Propylene Glycol: The solution for mites...at the time

- Glycerol/glycerine and Propylene Glycol both have a simple 3-carbon chain for their molecules.
- Glycerol has an alcohol group, -OH, on each of the three carbons.
- PG has alcohol groups just on the first 2 carbons.

![Glycerol](image1)
![Propylene Glycol](image2)
Propylene Glycol Toxic to Cats!!!

- 1990s PG was found to cause formation of “Heinz Body” red blood cells leading to anemia in cats
- Extreme cases caused deaths
- Removed from most/all cat treats
- Concerns exist about contamination from dog foods; product recalls
- Research continues on alternatives to Propylene Glycol
Screening GRAS Food-Coatings to Prevent Mite Infestations on Hams

20 Adult Mites Applied to Coated Ham Cube, Incubated for 14 days, Resulting Population Counted
# Effect of Glycerol Dips on Mite Infestation

<table>
<thead>
<tr>
<th></th>
<th>Mean Mites</th>
<th>(SE)</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>water control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Glycerol</td>
<td>367.4</td>
<td>(24.2)</td>
<td>a</td>
</tr>
<tr>
<td>glycerol in water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 %</td>
<td>343.6</td>
<td>(25.6)</td>
<td>a</td>
</tr>
<tr>
<td>50 %</td>
<td>323.2</td>
<td>(19.9)</td>
<td>ab</td>
</tr>
<tr>
<td>100 %</td>
<td>279.2</td>
<td>(20.3)</td>
<td>b</td>
</tr>
</tbody>
</table>
Population growth of mites on ham cubes treated with different concentrations of Propylene Glycol
Population growth of *Tyrophagus putrescentiae* on ham treated with different short-chain alcohols
Population growth of *Tyrophagus putrescentiae* on ham treated with BHT and BHA

[Graph showing population growth of *Tyrophagus putrescentiae* on ham treated with control, ethanol, BHA 10%, and BHT 10%. The graph indicates that BHT and BHA significantly reduce the population growth compared to control and ethanol.]
Orientation of mites to treated ham cubes

Mean number (±SE) of mites

- Glycerol 100%
- Propylene Glycol 100%
- Calcium Propionate 10%
- Sodium Sorbate 10%

Control
Dipped

Untreated
Treated
Egg placement by mites to treated vs untreated ham cubes after 24 hrs.
Test of Food Gels w/PG to protect hams

Mean mite progeny produced on coated ham pieces from 20 mites after 14 days

- Water control 273
- PG-Alginate only 54
- Carrageenan only 28
- Agar only 111
- Xanthum gum only 29
- PG-Alginate w/50% PG 0
- Carrageenan w/50% PG 0
- Agar w/50% PG 0
- Xanthum gum w/50% PG 0
Mean number of mites on ham cubes (20 mites inoculated/cube) coated with polysaccharides and different percentage of propylene glycol (PG) after 2 weeks incubation.

<table>
<thead>
<tr>
<th>Polysaccharides</th>
<th>PG</th>
<th>Mite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Control</td>
<td>0%</td>
<td>476&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>PGA (1%) + CG (1%)</td>
<td>0%</td>
<td>186&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>XG (1%)</td>
<td>0%</td>
<td>155&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>XG (1%)</td>
<td>10%</td>
<td>70&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>PGA (1%) + CG (1%)</strong></td>
<td>10%</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>XG (1%)</strong></td>
<td>20%</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
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PGA: propylene glycol alginate
CG: carrageenan
XG: xanthan gum.
Nets could be made to keep mites off

Apply Gels with PG to Ham
Tested carrageenan, propylene glycol alginate and Xanthan

Challenge PG Gels w/Mites

Coat Nets w/PG Gels
Textile Engineers
Can we monitor mites for IPM decisions?

The USDA meat inspector does not like this....
“KSU Trap” for Monitoring Mites

Trapping serves to:
- Detect presence of mites
- Monitor infestation over time and space
- A decision-making tool: it’s OK,..or treat!
Trap catch by week
Monitor Fumigation Recovery

Methyl Bromide Fumigation
Trap catch by trap location

[Graph showing trap catch by location in Rooms 1 and 2]
Mean number (±SE) of mites/trap (n=6)

KSU BT Insect ltd Dome Xlure

No-choice tests with different trap designs
Enhancing (or Reducing) Orientation Responses with Light

Mean number (±SE) of mites/trap (n=6)

Traps with different LEDs

- Red
- Yellow
- Green
- Blue
- Violet
- Ultraviolet
- White
- No LED
Controlling Mite Infestations Without Methyl Bromide

- Other fumigants
  - Phosphine
  - Sulfuryl Fluoride
- Controlled atmospheres: Low $O_2$, High $CO_2$, $O_3$
- Temperature extremes: Hot or Cold
- Combination methods?
- Pesticide sprays for floors/walls
- “New” Fumigants
Controlled Laboratory Fumigations
Mite Mortality w/ Sulfuryl Fluoride: 48h, 25°C

- **Concentration (g/m³)**: 0, 8.58, 11.13, 18.46, 22.49, 28.37, 54.48, 99.58
- **Mortality (%)**
  - Eggs
  - Adults

- **Label rate=1500 g.h m⁻³**
- **3X Label rate**
Phosphine Works for Ham Mites!

But not good for copper…

The bar chart shows the mortality (%) of eggs and nymph/adults at different PH₃ concentrations (g/m³).

- Eggs: Light gray bars
- Nymph/Adults: Dark gray bars

Concentrations tested: 0, 0.05, 0.11, 0.22, 0.41, 0.70, 0.85 g/m³

Mortality increases with PH₃ concentration for both eggs and nymph/adults.
Mite Mortality from Heat: Oven studies

**Eggs @ 40°C**

- 24 hrs: 20%, 48 hrs: 50%, 72 hrs: 70%, 96 hrs: 90%, ctrl: 100%

**Eggs @ 42°C**

- 6 hrs: 20%, 12 hrs: 50%, 18 hrs: 70%, 24 hrs: 90%, 40 hrs: 90%, 48 hrs: 90%, ctrl: 100%

**Adults and Nymphs at 40°C**

- 23% at 18 h, 25% at 24 h, 35.5% at 28 h, 58% at 32 h, 72.5% at 36 h, 99% at 40 h, 100% at 48 h, 98% at 48 h, 100% at 72 h, ctrl: 1.5%

**Adults and Nymphs @ 42°C**

- 19.5% at 4 h, 26.5% at 6 h, 42% at 12 h, 100% at 18 h, 100% at 24 h, 100% at 48 h, 100% at 48 h, ctrl: 2%
Cold Treatment for Mite Mortality: Freezer studies

- Adults and Nymphs @ -7 C
  - 6 hrs: 20%
  - 12 hrs: 40%
  - 18 hrs: 60%
  - 24 hrs: 80%
  - 48 hrs: 100%
  - Ctrl: 100%

- Eggs @ -7 C
  - 6 hrs: 20%
  - 12 hrs: 40%
  - 18 hrs: 60%
  - 24 hrs: 80%
  - 48 hrs: 100%
  - Ctrl: 100%

- Adults and Nymphs @ -10 C
  - 18 hrs: 100%
  - 24 hrs: 100%
  - 48 hrs: 100%
  - Ctrl: 100%

- Eggs @ -10 C
  - 6 hrs: 50%
  - 12 hrs: 70%
  - 18 hrs: 90%
  - 24 hrs: 100%
  - 48 hrs: 100%
  - Ctrl: 100%

(=19°F)

(=14°F)
Screening Spray-on Pesticides

- Completely randomized design
- 20 unsexed adult mites

- Glass Vials treated with \( \frac{1}{2} \times \) label rate, 1 \( \times \) label rate and 2 \( \times \) label rate
Residual sprays for surfaces

- **Storcide II®**
  - Control
  - 1/2 Label rate
  - 1 Label rate
  - 2 Label rate

- **Phantom®**
  - Control
  - 0.005 Label rate
  - 0.01 Label rate
  - 0.1 Label rate
Residual activity on three surfaces

• Prepare dishes with three surfaces: concrete, metal and wood
• Artist’s air brush to spray all dishes with label rates of Phantom, Storcid-II and Malathion
• Assay 20 mites per dish on dishes of different post-spray ages, up to 8 weeks
• Expose for 24 hrs and assess after 24 hrs recovery on clean dish
Ham mite mortality after 24-h exposure on sprayed surface up to 8 weeks post-spray
“Liquid” Fumigants

Propylene Oxide  
$\text{mw}=58$, $\text{bp}=34^\circ \text{C}$

Ethyl Formate  
$\text{mw}=74$, $\text{bp}=54^\circ \text{C}$
Ethyl Formate: Dose-Mortality Tests
24 Hrs @ 25° C

Approx. 100 mg/L
Propylene Oxide: Dose-Mortality Tests

24 Hrs @ 25° C

% Mortality vs. Log[PPO (mg/L)]

10-100 mg/L
IPM for Pet Foods

- Sanitation: clean up and destroy all infested materials
- Practice prevention: clean, clean, clean again..
- Use traps to detect & monitor pest populations
- Fumigate only when necessary
- Heat treatments can disinfest buildings
- Cold treatments could disinfest packages
- Newly registered fumigants may help