



*Benha University
Faculty of Agriculture
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Use of some safe materials for controlling some stored product insects

By

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M.Sc. (Economic Entomology), Fac. Agric., Benha University Egypt, 2012.

Thesis

**Submitted in Partial Fulfillment of the
Requirements
For the Degree of**

DOCTOR OF PHILOSOPHY

In

**Agricultural Sciences
(Economic Entomology)**

**Department of Plant Protection
Faculty of Agriculture
Benha University**

2019

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5. SUMMARY

The main objective of this work was:

- 1-Evaluate the efficacy of Ozone gas against the larvae and eggs of *Ephesi cautella* and the larvae and adults of *Oryzaephilus. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.
- 2-Determination of effectiveness of controlled atmospheres of Argon (AR) against the larvae and eggs of *E. cautella* and the larvae and adults of *O. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.
3. Evaluation of the efficacy of some botanical oils Camphor, Chamomile, Onion and Bitter almond oil against the larvae and eggs of *E. cautella* and the larvae and adults of *O. surinamensis* at two test temperatures 30 and $20 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.
- 4- The combined action of botanical oils and controlled atmospheres (AR + oil) against the larvae and eggs of *E. cautella* and the larvae and adults of *O. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.

5.1. Mortality of the tested ozone gas against larvae and eggs of *E. cautella* and adults and larvae of *O. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.

The results showed that the mortalities increased gradually by increasing each of exposure time to ozone gas and period after treatment against the larvae and eggs of *E. cautella* and adults and larvae of *O. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH. The susceptibility of the larvae, eggs of *E. cautella* and adults, larvae of *O. surinamensis*, showed that the eggs were more tolerance than larvae the adults of *O. surinamensis* were more tolerance than larvae at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.

For example:

The time required to obtain 50% mortality for the larvae and eggs of *E. cautella* and adults and larvae of *O. surinamensis* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.

The larvae of *E. cautella*

The time required to obtain 50% mortality for the larvae of *E. cautella* exposed to ozone at 300 ppm at 30°C was 14.30 day, at 0.5h exposure period and 1.96 day at 4 hrs, exposure period.

The eggs of *E. cautella*

The time 0 to obtain 50% mortality for the eggs of *E. cautella* exposed to ozone at 300 ppm at 30°C was 2.08 hrs.

The adults of *O. surinamensis*

The time required to obtain 50% mortality for the adults of *O. surinamensis* exposed to ozone at 300 ppm at 30°C was 22.27 and 2.43 day at 1 and 4 hrs, respectively

The larvae of *O. surinamensis*

The time required to obtain 50% mortality for the larvae of *O. surinamensis* exposed to ozone at 300 ppm at 30°C was 21.39 and 2.18 day at 0.5 and 4 hrs, respectively.

5.2. Effect of the controlled atmospheres (CA) containing various concentrations of argon (AR) against *E. cautella* and *O. surinamensis* under $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH.

The results showed that increasing the argon concentration of the controlled atmospheres resulted in higher efficacy against the larvae and eggs of *E. cautella* and adults and larvae of *O. surinamensis*. The efficacy of various argon concentrations increased with increasing the exposure period. The susceptibility of the various *E. cautella* stages varied from insect stage to another the eggs were more tolerance than

larvae and adults and larvae of *O. surinamensis* varied from insect stage to another the adults of *O. surinamensis* were more tolerance than larvae at $30 \pm 1^\circ\text{C}$ and $65\pm 5\%$ RH.

The larvae and eggs of *E. cautella*

Using 25% of argon caused 50% mortalities (lethal time values) for the larvae were 3.26 day, while it was 3.98 day for the eggs.

Using 50% of argon caused 50% mortalities (lethal time values) for the larvae were 1.48day, while it was 3.35day for the eggs.

Using 75% of argon caused 50% mortalities (lethal time values) for the larvae 1.02 day, while it was 2.78day for the eggs.

The adults and larvae of *O. surinamensis*

Using 25% of argon caused 50% mortalities (lethal time values) for the adults was 5.33 day, while it was 1.78 day for the larvae.

Using 50% of argon caused 50% mortalities (lethal time values) for the adults was 3.90 day, while it was 1.29day for the larvae.

Using 75% of argon caused 50% mortalities (lethal time values) for the adults was 3.34 day, while it was 0.83day for the larvae.

5.3. Effect of some botanical oils against *E. cautella* and *O. surinamensis* at $30 \text{ \& } 20 \pm 1^\circ\text{C}$ and $65\pm 5\%$ RH.

In case of larvae of *E. cautella* and adults of *O. surinamensis*, a sample of 10g of artificial diet was separately mixed thoroughly with each oil at concentrations ranged between 3 - 15 % in petroleum ether.

In case of eggs of *E. cautella*, a sample of 10g of artificial diet was separately mixed thoroughly with each oil at concentrations ranged between 0.5 – 3 % in petroleum ether.

In case of larvae of *O .surnamensis*, a sample of 10g of artificial diet was separately mixed thoroughly with each oil at concentrations ranged between 0.125 - 1 % in petroleum ether.

The results showed that the mortality increased by increasing the botanical oil concentration, period of exposure and temperature.

The larvae of *E. cautella*

Camphor oil

The result indicated that the larval mortality of *E. cautella* at 30&20 ± 1°C and 65 ± 5% RH, the mortality after 10 days post treatment at 5% (v/w) was 90.00% and 83.33% at 30°C and 20°C, respectively.

Chamomile oil

The result indicated that the larval mortality of *E. cautella* at 30&20 ± 1°C and 65 ± 5% RH, the mortality after 10 days post treatment at 10% (v/w) was 96.66% and 86.66% at 30 °C and 20°C, respectively.

Onion oil

The result indicated that the larval mortality of *E. cautella* at 30&20 ± 1°C and 65 ± 5% RH, the mortality after 10 days post treatment at 10% (v/w) was 93.33% and 83.33% at 30°C and 20°C, respectively.

Bitter almond oil

The result indicated that the larval mortality of *E. cautella* at 30&20 ± 1°C and 65 ± 5% RH, the mortality after 10 days post treatment at 10% (v/w) was 90.00% and 80.00% at 30°C and 20°C, respectively.

The eggs of *E. cautella*

The results showed that the reduction increased by increasing the botanical oils concentration, period of exposure and temperature.

Camphor oil

The result indicated that the eggs mortality of *E. cautella* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH, the eggs mortality of *E. cautella* at concentration 0.5% (v/w) was 35.1 and 30.96% at 30.00°C and 20°C , respectively.

Chamomile oil

The result indicated that the eggs mortality of *E. cautella* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH, the mortality at 3% (v/w) was 84.30% and 82.14% at 30°C and 20°C , respectively.

Onion oil

The result indicated that the eggs mortality of *E. cautella* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH, the mortality at 3% (v/w) was 81.90% and 81.00% at 30 and 20°C , respectively.

Bitter almond oil

The result indicated that the eggs mortality of *E. cautella* at $30 \pm 1^\circ\text{C}$ and $65 \pm 5\%$ RH, the eggs mortality of *E. cautella* at concentration 0.5% (v/w) was 22.80 and 17.85% at 30°C and 20°C , respectively.

The adults of *O. surinamensis*

The results showed that the mortality increased by increasing the botanical oils concentration, period of exposure and temperature.

Camphor oil

The result indicated that the adults mortality of *O. surinamensis* after 12 days post-treatment with various concentrations of Camphor

oil was between 21.66 -86.65% and 18.33 – 80.00 % at 30, 20 °C, respectively. The estimated The LC₅₀ values 4.17 and 7.92% at 30°C and 20°C, respectively

Chamomile oil

The result indicated that the adults mortality of *O. surinamensi* after 12 days post-treatment with various concentrations of chamomile oil was between 30.00 -95.00% and 20.00 – 85.00 % at 30°C and 20 °C, respectively. The estimated The LC₅₀ values 7.94 and 12.86% at 30 and 20 °C, respectively

Onion oil

The result indicated that the adults mortality of *O. surinamensi* after 12 days post-treatment with various concentrations of onion oil was between 20.00 -90.00% and 18.33 – 78.33 % at 30, 20 °C, respectively. The estimated The LC₅₀ values 8.26 and 13.10% at 30 and 20 °C, respectively.

Bitter almond oil

The result indicated that the adults mortality of *O. surinamensi* after 12 days post-treatment with various concentrations of bitter almond oil was between 35.00 -100.00% and 20.00 – 86.65 % at 30°C and 20 °C, respectively. The estimated The LC₅₀ values 7.28 and 12.97% at 30°C and 20 °C, respectively.

The larvae of *O. surinamensis*

Camphor oil

The result indicated that the larval mortality of *O. surinamensi* after 10 days post-treatment with various concentrations of camphor oil was between 43.33-93.33% and 30.00 – 90.00 % at 30°C and 20°C, respectively. The estimated The LC₅₀ values 0.19 and 0.26% at 30°C and 20 °C, respectively.

Chamomile oil

The result indicated that the larval mortality of *O. surinamensi* after 10 days post-treatment with various concentrations of chamomile oil was between 30.00-100.00% and 26.66 – 93.33% at 30°C and 20°C, respectively. The estimated The LC₅₀ values 0.25 and 0.28% at 30°C and 20 °C, respectively.

Onion oil

The result indicated that the larval mortality of *O. surinamensi* after 10 days post-treatment with various concentrations of onion oil was between 23.3-100% and 23.3 – 90% at 30°C and 20°C, respectively. The estimated The LC₅₀ values 0.30 and 0.31% at 30°C and 20 °C, respectively

Bitter almond oil

The result indicated that the larval mortality of *O. surinamensi* after 10 days post-treatment with various concentrations of bitter almond oil was between 30.00-93.33% and 23.33–86.66% at 30°C and 20 °C, respectively. The estimated The LC₅₀ values 0.26 and 0.32% at 30°C and 20 °C, respectively.

The camphor oil was the most effective against larvae of *E. cautella* and egg and adults of *O. surinamensis* and larvae followed by chamomile oil or onion oil and bitter almond oil were the least effective oils.

5.4. The combined action of the botanical oils and argon against larvae and eggs of *E. cautella* and adults and larvae of *O. surinamensis* at 30±1°C and 65±5% RH.

Controlled atmospheres of LT₅₀ of 50% argon were tested (alone and in mixture) with LC₅₀ of camphor, chamomile, onion and bitter

almond botanical oils, for *E. cautella* larvae and eggs and *O. surinamensis* adults and larvae at $30 \pm 1^\circ\text{C}$. Then experiments were conducted in circulatory glass apparatus in the laboratory at 30°C and $65 \pm 5\%$ R.H.

5.4.1. Larvae of *E. cautella*

5.4.1.1. Camphor

The combined action of camphor oil at LC_{50} (3.73) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (0.68) day after 7 days post treatment against larvae of *E. cautella* at 30°C and $65 \pm 5\%$ RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 16.66% and 23.33% to 26.66% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 56.6% and 63.3% to 100% for oil, gas and oil+ gas, respectively.

5.4.1.2. Chamomile oil

The combined action of chamomile oil at LC_{50} (7.33) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (0.68) day after 7 days post treatment against larvae of *E. cautella* at 30°C and $65 \pm 5\%$ RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 6.66% and 23.33% to 26.66% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 40.00% and 63.33% to 96.66% for oil, gas and oil+ gas, respectively.

5.4.1.3. Onion oil

The combined action of onion oil at LC_{50} (7.54) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon

at LT_{50} (0.68) day after 7 days post treatment against larvae of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 6.66% and 23.33% to 30.00% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 56.66% and 63.33% to 100.00% for oil, gas and oil+ gas, respectively.

5.4.1.4 Bitter almond oil

The combined action of bitter almond oil at LC_{50} (7.69) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (0.68) day after 7 days post treatment against larvae of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 10.00% and 23.33% to 23.33% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 53.33% and 63.33% to 90.00% for oil, gas and oil+ gas, respectively.

5.4.2. Eggs of *E. cautella*

5.4.2.1. Camphor oil

The combined action of camphor oil at LC_{50} (0.89) % (v/w) under modified atmospheres (MA) of 50 % argon at LT_{50} (3.35) day against egg of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C from 48.80% and 55.60% to 96.24% for oil, gas and oil+ gas, respectively.

5.4. 2.2. Chamomile oil

The combined action of chamomile oil at LC_{50} (1.09) % (v/w) under modified atmospheres (MA) of 50 % argon at LT_{50} (3.35) day

against egg of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C from 52.20% and 55.60% to 96.24% for oil, gas and oil+ gas, respectively.

5.4.2.3. Onion oil

The combined action of onion oil at LC₅₀ (1.25) % (v/w) under modified atmospheres (MA) of 50 % argon at LT₅₀ (3.35) day against egg of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C from 52.20% and 55.60% to 96.24% for oil, gas and oil+ gas, respectively.

5.4.2.4. Bitter almond oil

The combined action of bitter almond oil at LC₅₀ (1.33) % (v/w) under modified atmospheres (MA) of 50 % argon at LT₅₀ (3.35) day of 50% argon against egg of *E. cautella* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C from 50.17% and 55.6% to 100% for oil, gas and oil+ gas, respectively.

5.4.3. Effect of LC₅₀ of botanical oils under LT₅₀ of 50% argon against the adult of *O. surinamensis*

5.4.3.1. Camphor oil

The combined action of camphor oil at LC₅₀ (4.17) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT₅₀ (3.90) day after 1day post treatment against the adults of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 0.00% and 40.00% to 76.65% for oil, gas and oil+ gas, respectively. While improved mortality values after

12 day post treatment were from 45.00% and 40.00% to 91.65% for oil, gas and oil+ gas, respectively

5.4.3.2. Chamomile oil

The combined action of chamomile oil at LC_{50} (7.94) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (3.90) day after 1day post treatment against the adults of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 20.00% and 40.00% to 75.00% for oil, gas and oil+ gas, respectively. While improved mortality values after 12 day post treatment were from 60.00% and 40.00% to 90.00% for oil, gas and oil+ gas, respectively.

5.4.3.3. Onion oil

The combined action of onion oil at LC_{50} (8.26) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (3.90) day after 1day post treatment against the adults of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 16.65% and 40.00% to 78.33% for oil, gas and oil+ gas, respectively. While improved mortality values after 12 day post treatment were from 48.33% and 40.00% to 96.66% for oil, gas and oil+ gas, respectively.

5.4.3.4. Bitter almond oil

The combined action of bitter almond oil at LC_{50} (7.87) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT_{50} (3.90) day of 50% argon after 1day post against the adults of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 18.35% and 40.00% to 75% for oil, gas

and oil+ gas, respectively. While improved mortality values after 12 day post treatment were from 56.5% and 40% to 90% for oil, gas and oil+ gas, respectively.

5.4.4. Effect of LC₅₀ of botanical oils under LT₅₀ of 50% argon against the larvae of *O. surinamensis*:

5.4.4.1. Camphor oil

The combined action of camphor oil at LC₅₀ (0.19) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT₅₀ (0.69) day of 50% argon after 7 days post treatment against the larvae of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 13.33% and 16.66% to 26.66% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 50.00% and 36.66% to 100.00% for oil, gas and oil+ gas, respectively.

5.4.4.2. Chamomile oil

The combined action of chamomile oil at LC₅₀ (0.25) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT₅₀ (0.69) day of 50% argon after 7 days post treatment against the larvae of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 16.66% and 16.66% to 23.3% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 46.66% and 36.66% to 96.66% for oil, gas and oil+ gas, respectively

5.4.4.3 Onion oil

The combined action of onion oil at LC₅₀ (0.30) % (v/w) after 10 days post treatment under modified atmosphere (MA) of 50 % argon at

LT₅₀ (0.69) day of 50% argon after 7 days post treatment against the larvae of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 13.33% and 16.66% to 30.00% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 46.66% and 36.66% to 100.00% for oil, gas and oil+ gas, respectively.

5.4.4.4. Bitter almond oil

The combined action of bitter almond oil at LC₅₀ (0.26) % (v/w) after 10 days post treatment under modified atmospheres (MA) of 50 % argon at LT₅₀ (0.69) day of 50% argon after 7 days post treatment against the larvae of *O. surinamensis* at 30°C and 65±5%RH, general, improved mortality values than those achieved with each component separately at 30°C after 1 day post treatment from 16.66% and 16.66% to 26.66% for oil, gas and oil+ gas, respectively. While improved mortality values after 10 day post treatment were from 40.00% and 36.66% to 100.00% for oil, gas and oil+ gas, respectively.