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# Differential Effects of Eucalyptus, Garlic, Rosemary, and Basil Smokes on *Varroa destructor* Mite Fall and *Apis mellifera* Colony Calmness

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**ABSTRACT**

Varroa destructor continues to cause major winter losses in Apis mellifera apiaries across Iraq, while repeated use of synthetic acaricides has led to resistance and residue concerns. Plant-based smoke may provide a low-cost alternative, but beekeepers need a practical delivery method. We tested four botanical smokes using compressed cardboard egg cartons—a common smoker fuel in local apiaries—as a substrate to extend burn time. Garlic smoke gave the highest might fall at 95.6% efficacy, whereas eucalyptus smoke produced the calmest colonies at 4.5/5.0. This indicates treatment choice can be matched to the beekeeper's immediate need.

**Methods:** We worked with 36 equal-strength colonies in babylon from March–May 2025. Groups received 30-second smoke applications of *Eucalyptus camaldulensis*, *Allium sativum*, *Rosmarinus officinalis*, or *Ocimum basilicum* mixed with egg carton, plus egg carton-only and untreated controls. Mite fall was counted on sticky boards after 48 h. Calmness was scored 0–5 by the same observer during inspection. Data were compared using One-Way ANOVA and Duncan's test, $P \leq 0.05$.

**Results:** Garlic smoke produced 3.83 ± 0.19 mites/colony/48h, significantly more than all other treatments. Eucalyptus smoke gave the highest calmness score at 4.50 ± 0.22. Rosemary and basil showed intermediate effects. Egg carton alone had minimal impact.

**Conclusion:** Garlic smoke is suited for targeted Varroa knockdown when mite counts are high, and eucalyptus smoke for routine inspections where beekeeper safety matters. Using egg carton as a carrier makes the method affordable and easy to adopt in organic IPM programs.

**KEY WORDS:** Varroa destructor; Apis mellifera; Botanical smoke; Eucalyptol; Allicin; Organic beekeeping; IPM; Egg carton substrate

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## INTRODUCTION

Controlling Varroa destructor is now a routine part of beekeeping in Iraq, as the mite directly damages the fat body of Apis mellifera and spreads viruses that trigger colony collapse. While products like amitraz and fluvalinate are still available, many local beekeepers have noticed weaker results after repeated seasons and are concerned about residues in honey and wax.

Plant volatiles offer another route. Compounds from Eucalyptus camaldulensis and Allium sativum have killed Varroa in laboratory dishes, but translating that to the field is difficult. Essential oils are costly and volatilize too fast in our summer heat. In practice, beekeepers here burn pieces of cardboard egg carton in smokers because they are free and smolder for 10–15 minutes. This observation led us to test whether egg carton could act as a slow-release carrier for ground plant material, effectively turning each hive inspection into a treatment.

To date, we found no published field work comparing different botanical smokes delivered this way. Therefore, we designed a simple trial with two practical questions: which plant smoke drops the most mites within 48 h, and which one keeps the bees

calmest during the check? The aim was to give beekeepers clear, crop-season advice: reach for garlic when mite numbers spike, and eucalyptus when a calm hive is the priority.

## MATERIALS AND METHODS

**Study site and colonies :**

We ran the trial from March to May 2025 in a private apiary in Babylon Governorate, Iraq (33.3152° N, 44.3661° E). We selected 36 *Apis mellifera* colonies housed in Langstroth hives, all headed by one-year-old queens and of similar strength. Colonies were naturally infested with *Varroa destructor* and had received no miticide for at least 6 months.

**Experimental design :**

Colonies were split into six groups of six: (1) E. camaldulensis leaves + egg carton, (2) A. sativum cloves + egg carton, (3) R. officinalis leaves + egg carton, (4) O. basilicum leaves + egg carton, (5) egg carton only, and (6) no treatment. We repeated each measurement three times per colony.

**Preparation of botanical smokes :**

We dried and coarsely ground each plant. For treatments, we mixed 10 g plant powder with 20 g torn egg carton and lit it in a standard bee smoker. The egg carton-only group used 30 g egg carton with no plant. We applied smoke for 30 seconds through the entrance between 11:00–13:00 when bee flight was lowest.

**Assessment of mite fall :**

Before smoking, we slid a 30 × 40 cm white board coated with petroleum jelly onto each bottom board. After 48 h we retrieved boards and counted V. destructor under a stereomicroscope. Efficacy was calculated against the egg carton control using Abbott's formula.

**Assessment of colony calmness** :

Ten minutes after smoking, the same experienced beekeeper opened each hive and scored defensive behavior from 0 = mass attack to 5 = no defensive flight. Using one observer removed bias between colonies.

**Statistical analysis :**

After checking normality with Shapiro-Wilk and variance with Levene's test, we ran One-Way ANOVA in SPSS v.26.0. Means were separated with Duncan's test at $P \leq 0.05$.

## RESULTS:

Botanical smoke type clearly changed both mite fall and bee temperament ($P < 0.01$; Table 1). Garlic + egg carton dropped 3.83 ± 0.19 mites/colony/48h, giving 95.6% efficacy. Eucalyptus followed at 2.50 ± 0.22, then rosemary 1.67 ± 0.21, and basil 1.17 ± 0.17. Egg carton alone dislodged only 0.17 ± 0.09 mites, and untreated hives dropped none.

For calmness, eucalyptus smoke was best at 4.50 ± 0.22 out of 5.0, higher than all others. Garlic also helped at 3.17 ± 0.31 compared to 2.00 ± 0.26 for untreated. Rosemary and basil were in between. The egg carton-only group scored the same as untreated, confirming that plant volatiles, not smoke alone, caused the effects.

**Table 1. Effect of botanical smoke treatments delivered via egg carton substrate on *Varroa destructor* mite fall and *Apis mellifera* colony calmness**.

| Treatment | Mite fall (mites/colony/48h) | Efficacy (%) | Calmness score (0–5) |
|---|---|---|---|
| Eucalyptus camaldulensis + Egg carton | 2.50 ± 0.22 b | 62.5 | 4.50 ± 0.22 a |
| Allium sativum + Egg carton | 3.83 ± 0.19 a | 95.6 | 3.17 ± 0.31 b |
| Rosmarinus officinalis + Egg carton | 1.67 ± 0.21 c | 41.8 | 2.83 ± 0.31 bc |
| Ocimum basilicum + Egg carton | 1.17 ± 0.17 d | 29.3 | 2.67 ± 0.21 c |
| Egg carton only | 0.17 ± 0.09 e | — | 2.00 ± 0.37 d |
| Untreated control | 0.00 ± 0.00 e | — | 2.00 ± 0.26 d |

Values are mean ± SE (n = 6 colonies, 3 replicates each). Different letters in a column indicate significant differences by Duncan's test, $P \leq 0.05$. Efficacy relative to egg carton control.

## DISCUSSION

The results give beekeepers a practical decision tool. When mite counts are high, garlic smoke is the strongest option, likely because allicin vapors disrupt mite nerves and breathing. When the main concern is a safe inspection, eucalyptus smoke is better because eucalyptol masks alarm pheromone and keeps bees settled.

The egg carton method matters for two reasons. First, it burns 3–4 times longer than loose leaves, so plant compounds have time to circulate. Second, every beekeeper we know already has egg cartons, so adoption needs no new cost or equipment. This solves the main field complaint about essential oils: they are too expensive and gone too fast.

Rosemary and basil helped a little but not enough to recommend as stand-alone treatments. Their monoterpenes may need higher doses or different timing. Essential oils have shown acaricidal activity against V. destructor in laboratory studies [7,8], with feeding trials also reporting effects on mite populations [9]. The fact that egg carton alone did almost nothing proves the plants, not the smoke particles, did the work.

This was a 48-h snap-shot. We still need to test whether weekly smoking hurts brood, changes honey taste, or if mites develop tolerance to allicin. A sensible rotation could be garlic during brood breaks when mites are phoretic, and eucalyptus during honey flow when calm hives matter most.

## CONCLUSION

Mixing ground botanical material with egg carton in a smoker gives beekeepers a flexible, low-cost tool. Use garlic for mite knockdown and eucalyptus for calm inspections. The approach fits organic IPM and uses materials already present in most apiaries.

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