[P47] Liquid and solid matrix formic acid treatment comparison against Varroa mites in honey bee colonies

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Background

Control of the mite *Varroa destructor* in honeybee colonies (*Apis mellifera*) is preferably performed by beekeepers using organic acids considering mite-resistance to synthetic acaricides. An advantage of formic acid usage in colonies is that it penetrates the wax lids of bee brood cells in which the mite reproduces. Because formic acid is a corrosive liquid and gives off a corrosive vapor, its use is not without risks for the beekeeper. Another disadvantage is that if the concentration is too low, varroa control works poorly, and that too high doses can cause brood damage and queen mortality. For these reasons, beekeepers experience formic acid treatments as difficult.

Objective

We tested the performance of two **formic acid** applications to inform Dutch beekeepers.

A **solid** matrix product (Formic Pro; n=10 colonies) was compared to a **liquid** application (220 ml 60% Formivar; n=10 colonies). These products are registered for veterinary use in honeybee colonies (REG NL 126198 and REG NL 118709, resp.). Untreated colonies were negative **controls** (n=10). Regarding forage dearth, all 30 colonies were fed sugar fondant during the experiment.

- ***Mite counts*** were performed every 2nd day on the bottom boards (Fig. 1; Aug 18th till Oct 18th).
- ***Efficacy*** of treatment was assessed by dividing dead mite counts after treatment (Aug 30th – Oct 4th) by overall dead mite counts (Aug 30th - Oct 18th), regarding two follow-up treatments by spraying a 3.5% oxalic acid solution, in absence of honey bee brood (Oct 4th and 10th).
- ***Acidity*** in colonies was assessed with pH strips
- ***Breeding*** was checked pre- and mid-treatment
- ***Queens*** were checked pre- and post-treatment

30 experimental colonies at apiary

Liquid: Liebig ispenser

Solid: "*Formic Pro*" and fondant

Results mites

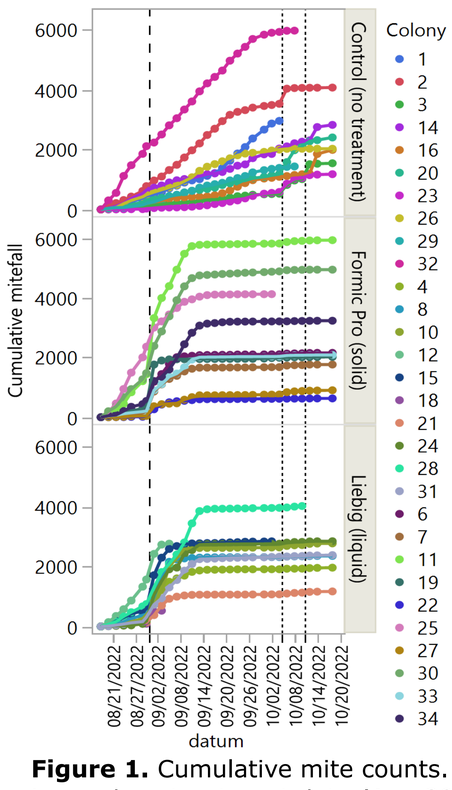

Figure 1. Cumulative mite counts. Lines show treatment date (Aug 30) and critical treatments (Oct 4 & 10)

In total, 77872 dead mites were counted during the experiment (Fig. 1); mean 2596 mites per colony (n=30).

The efficacy in killing varroa mites was mean **96.0 % ± 1.0 SE** for the solid and mean **95.4 % ± 2.0 SE** for the liquid formic acid application, with no significant difference (Fig. 2: $F_{1,12}$=0.06; p=0.81).

Mite counting (Fabrizio Freda)

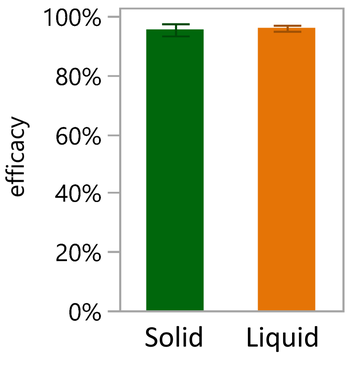

Figure 2. Efficacy of formic acid applications

Results pH

Treatments significantly affected the acidity of the hive environment (Fig. 3: $F_{2,309.5}$=457.0; p<0.001). The formic acid treatments did not differ among one another. However, in comparison to the control colonies, the solid and liquid applications increased the acidity of the hive environment by approximately two orders of magnitude.

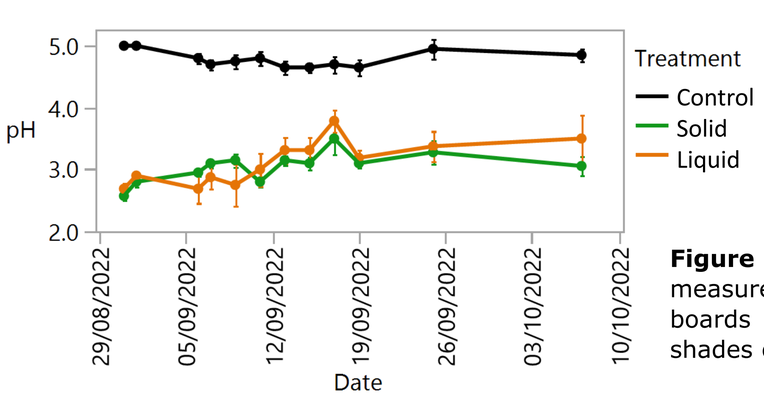

Figure 3: Acidity in colonies was measured with pH strips on the bottom boards in colonies by reading color shades of a standard indicator chart.

Results brood

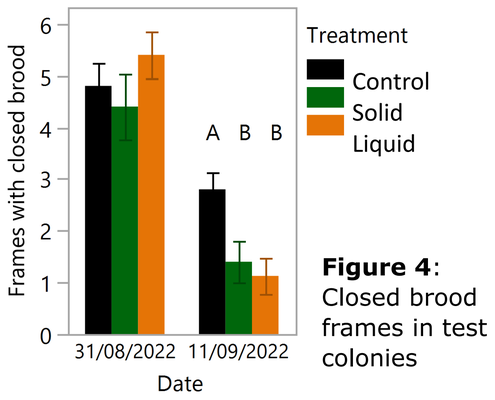

Figure 4: Closed brood frames in test colonies

Between Aug 31 and Sep 11, breeding in colonies significantly declined (Fig. 4: $F_{1,56}$=60.9; p<0.001). **Pre-treatment** (Aug 31), breeding did not differ between treatment groups ($F_{2,27}$=0.94; p<0.40). **Mid-treatment** (Sep 11), more breeding occurred in control colonies, as compared to the colonies treated with formic acid ($F_{2,25}$=6.17; p=0.007; Posthoc A B B).

Results queens

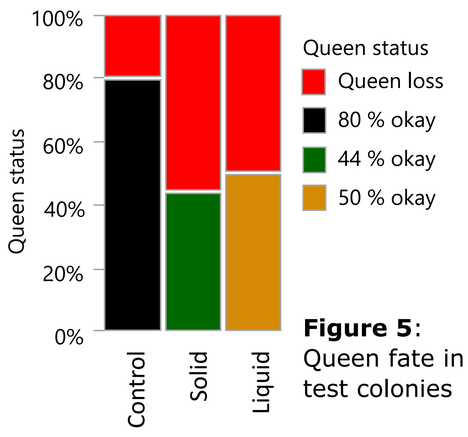

Figure 5: Queen fate in test colonies

Queen loss in control colonies was 20%. In formic acid treatments queen loss approximated 50%. The difference, **30% queen loss**, can be attributed due to formic acid (Fig. 5), albeit not significant (Fisher's ET, n=29, p=0.13).

N.B.: Five colonies **bearded** after treatment. Two colonies **absconded** due to formic acid stress.

Conclusion

Colonies suffered high mite loads (Fig. 1), with formic acid treatments killing >95% of the varroa mites (Fig. 2). Acidity in treated colonies elevated over a long-term period (Fig. 3). Disadvantageous was that formic acid reduced breeding (Fig. 4) and caused 30% loss of queens (Fig. 5), as compared to control colonies. Although the solid application was somewhat easier to use – the liquid and solid application impacted honeybee colonies to similar extents. We note that these test conditions were a "worst case" situation, as discussed in our paper on this study (Hendriksma et al., 2023).

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