ULST Timisoara

Multidisciplinary Conference on Sustainable Development

21-22 May 2026

2026 MULTIDISCIPLINARY CONFERENCE ON SUSTAINABLE DEVELOPMENT

CLASSICAL *vs*. NATURAL: EVALUATING THE EFFICACY, SAFETY, AND RESIDUE RISK OF VARROSIS TREATMENTS

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Abstract. **Varroa destructor is an external parasite responsible for significant damage to bee colonies across the globe. Selecting the most effective strategy to manage Varroa represents a challenging decision for beekeepers, shaped by numerous contributing factors. Each treatment approach — whether conventional or biological — involves a careful weighing of advantages and drawbacks, and making an informed choice requires a thorough understanding of all relevant aspects.**
This paper aims to examine the differences between these approaches in terms of efficacy, ease of application, side effects, and impact on bee products.
The study was carried out in Argeș County, Romania, involving 130 bee colonies from the family hive. The following treatments were applied: Varachet Forte, a fumigant solution administered directly through the hive opening; Marvirol, applied by placing impregnated strips between the hive frames; oxalic acid, administered as a drip solution; and Thymovar, applied by placing impregnated strips on top of the hive frames.
The greatest efficacy in mite control was recorded for Varachet Forte, with a mortality rate of 93.33%, followed by oxalic acid at 92.50%, Marvirol at 87.23%, and Thymovar at 79.20%.
Conventional treatments prove highly effective in rapidly reducing mite populations; however, they may leave residues in honey and wax, and can contribute to the development of mite resistance.

Introduction

Varroa destructor — the major external parasite of Apis mellifera, primary driver of colony losses worldwide.
Feeds on the fat body, weakening immunity, detoxification, and thermoregulation.

To control varroosis, beekeepers have traditionally relied on synthetic acaricides such as pyrethroids (e.g., tau-fluvalinate), formamidines (amitraz), and other neuroactive compounds . Although these conventional treatments act rapidly and provide high initial efficacy, their repeated use carries the risk of selecting resistant mite populations and of leaving residues in hive products such as honey and wax . Amitraz, in particular, exerts its selective toxicity through octopamine receptors, which explains both its effectiveness against mites and its relative safety for bees ; nevertheless, residues of amitraz and its metabolites have been frequently detected in treated colonies . More broadly, pesticide exposure — whether from in-hive treatments or from the surrounding agricultural environment — is recognized as a significant contributor to honey bee toxicity and colony decline .

In contrast, natural or "soft" treatments — such as oxalic acid and thymol — display a more favorable residue profile and are considered better suited for integrated and sustainable varroosis management. Oxalic acid, applied by trickling, sublimation, or spraying, has proven a reliable option under temperate climate conditions, achieving high efficacy without compromising hive product quality, although the impact of incremental vaporized doses on workers and queens still requires careful evaluation. Thymol, an essential-oil-derived compound, has likewise been shown to control mite populations effectively, although its persistence and distribution within hive compartments must be carefully monitored. Practical and management-based strategies aimed at reducing chemical inputs are also gaining attention as part of a broader, holistic approach to Varroa control.

Aim of the paper — compare conventional and natural treatments under field conditions in Argeș County, Romania.

Material and method

The study was conducted between 15 August and 30 October 2024 in an apiary located in Stolnici commune, Argeș County, Romania.
The apiary comprised 200 honey bee colonies of the Apis mellifera carpatica race, kept under a semi-intensive management system in vertical 11-frame hives.
From this stock, 130 colonies were selected for the experiment, matched as closely as possible in terms of vigour, developmental stage, and brood level.
All experimental hives were equipped with anti-Varroa screened bottom boards, a metal ventilation grid, and a removable collecting tray.

The colonies were divided into five groups:
- *Group 1 — 30 colonies*
- *Group 2 — 30 colonies*
- *Group 3 — 30 colonies*
- *Group 4 — 30 colonies*
- *Group 5 — 10 colonies*

All treatments were applied at the end of October, when the amount of capped brood in the hives was minimal, in order to maximize acaricidal contact with phoretic mites.

***Group 1** (Varachet Forte) — applied by fumigation at an outside temperature of 12 °C; the smoke was allowed to act inside the hive for 10–15 minutes, after which the hive entrance was reopened.*

***Group 2** (Mavrirol) — two impregnated strips were placed between the brood frames of each hive.*

***Group 3** (oxalic acid) — a solution was prepared from 35 g oxalic acid, 1 kg sugar, and 1 L of warm water; 5 mL of this solution was trickled with a graduated syringe along each bee-occupied frame interval.*

***Group 4** (Thymovar) — two impregnated cellulose plates were placed on top of the brood frames.*

***Group 5** (control — untreated colonies).*

Assessment
Sugar shake test — 300 bees/colony, before and 14 days post-treatment.
Infestation (%) = (mites × 100) / 300.
Efficacy (%) = ((initial – post) / initial) × 100.

Results and discussions

Initial infestation: 7.50 – 8.17%
All groups comparable at baseline (range overlap 6.67 – 8.67%).

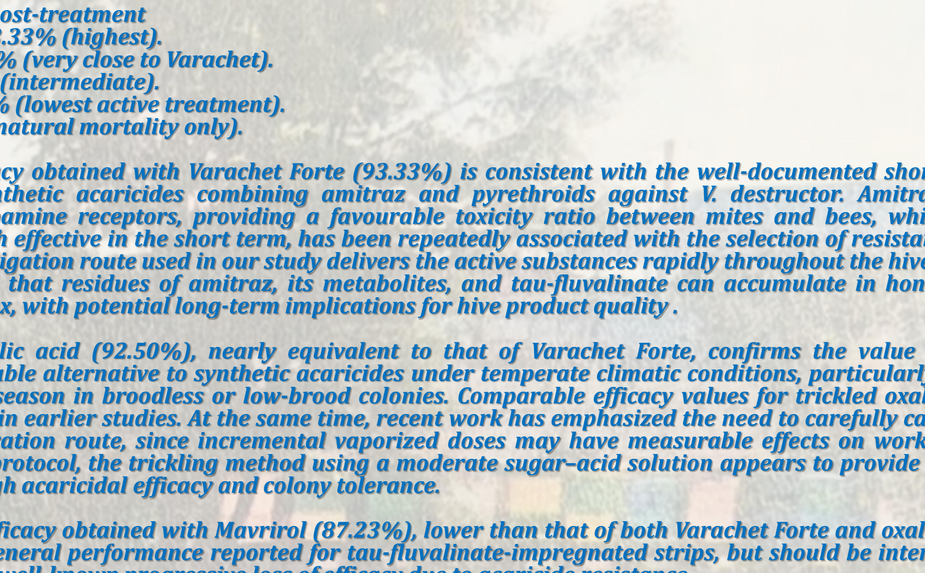
Efficacy at 14 days post-treatment
***Varachet Forte** — 93.33% (highest).*
***Oxalic acid** — 92.50% (very close to Varachet).*
***Mavrirol** — 87.23% (intermediate).*
***Thymovar** — 79.20% (lowest active treatment).*
***Control** — 11.34% (natural mortality only).*

The very high efficacy obtained with Varachet Forte (93.33%) is consistent with the well-documented short-term effectiveness of synthetic acaricides combining amitraz and pyrethroids against V. destructor. Amitraz acts selectively on octopamine receptors, providing a favourable toxicity ratio between mites and bees, while tau-fluvalinate, although effective in the short term, has been repeatedly associated with the selection of resistant mite population. The fumigation route used in our study delivers the active substances rapidly throughout the hive, but it must be considered that residues of amitraz, its metabolites, and tau-fluvalinate can accumulate in honey and especially in beeswax, with potential long-term implications for hive product quality .

The efficacy of oxalic acid (92.50%), nearly equivalent to that of Varachet Forte, confirms the value of this compound as a reliable alternative to synthetic acaricides under temperate climatic conditions, particularly when applied late in the season in broodless or low-brood colonies. Comparable efficacy values for trickled oxalic acid have been reported in earlier studies. At the same time, recent work has emphasized the need to carefully calibrate the dose and application route, since incremental vaporized doses may have measurable effects on worker and queen bees. In our protocol, the trickling method using a moderate sugar–acid solution appears to provide a good balance between high acaricidal efficacy and colony tolerance.

The intermediate efficacy obtained with Mavrirol (87.23%), lower than that of both Varachet Forte and oxalic acid, is in line with the general performance reported for tau-fluvalinate-impregnated strips, but should be interpreted in the context of the well-known progressive loss of efficacy due to acaricide resistance.

Thymovar showed the lowest efficacy of the active treatments tested (79.20%), a result that aligns with previous reports on thymol-based products, whose performance is markedly influenced by ambient temperature, hive ventilation, and colony strength. The persistence and uneven distribution of thymol in hive matrices, including honey and wax, have also been documented and may further affect both efficacy and product residue profiles. Despite a lower acaricidal performance compared with synthetic and acid-based treatments, thymol remains an attractive option as part of an integrated control strategy due to its more favorable residue profile and lower selection pressure for resistance, in agreement with recent practical syntheses of Varroa management.



Conclusions

1. ***All four tested products produced a marked reduction in Varroa destructor infestation compared with the untreated control.***
2. ***Varachet Forte showed the highest efficacy (93.33%), followed closely by oxalic acid (92.50%), with very similar performance between the two.***
3. ***Mavrirol produced an intermediate efficacy (87.23%), lower than that of Varachet Forte and oxalic acid.***
4. ***Thymovar had the lowest efficacy among the active treatments (79.20%).***
5. ***In the untreated control group, the natural reduction of mite infestation was minimal (11.34%), confirming that without intervention the parasite population remains at levels that compromise colony health.***
6. ***Trickled oxalic acid emerges as a highly effective natural alternative to synthetic acaricides, offering a comparable efficacy with a more favourable residue profile.***
7. ***Synthetic acaricides should be used with caution because of the risk of residues in hive products and of selecting resistant mite populations.***
8. ***From a practical perspective, the rotation of active substances and the integration of chemical and biotechnical methods represent the most rational approach for sustainable Varroa management.***

Aknowledgement: The authors thank the apiary owner and the team in Stolnici, Argeș County, for their support during the field study.