

Efficiency of laboratory diagnostic methods for varroosis in honey bees

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Abstract

Beekeeping plays an important role in human activity and is an integral part of agricultural development. The benefits of the honey bee are not limited to the production of beekeeping products. These insects also play a crucial role in the pollination of entomophilous plants, whose yields cannot be achieved without pollination processes. One of the major challenges in beekeeping is parasitic diseases, which cause significant economic losses and reduce the number of bee colonies. The most widespread and harmful disease of the honey bee is varroosis, which has become common in apiaries worldwide. This study aimed to determine the effectiveness of known laboratory diagnostic methods for detecting varroosis in honey bees. Under laboratory conditions, methods for examining dead bees (bee debris) and live honey bees for the presence of the mite *Varroa destructor* were compared using sunflower oil, boiling water, powdered sugar, and visual inspection. The number of positive samples determined the methods' sensitivity, and their efficiency was evaluated based on the number of *Varroa destructor* mites detected. Studies of dead bees revealed a high sensitivity of the boiling-water and sunflower-oil method (100.0%). The visual detection method for mites in bee debris had lower sensitivity (85.7%). Among the methods based on the number of detected mites in dead bees, the most effective were boiling water (5.6 ± 0.6 specimens) and sunflower oil (5.9 ± 0.5 specimens). A smaller number of mites was detected using the visual detection method (3.1 ± 0.6 specimens). High sensitivity and efficiency in the examination of live bees were observed with the powdered-sugar method (100.0% and 13.1 ± 1.5 specimens). Lower sensitivity and efficiency were observed with the visual inspection method (75.0% and 9.5 ± 1.2 specimens, respectively). The obtained research results allow recommending the most effective methods to improve the accuracy of diagnosing varroosis in honey bees.

Keywords: honey bees; *Varroa destructor*; varroosis; laboratory diagnostics; efficiency.

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1. Introduction

The development of beekeeping is currently hindered by infectious and non-infectious diseases of bees and their brood, which cause significant losses to the industry. One of these diseases is varroosis, a global problem for apiculture, as this infestation weakens and reduces bee colonies, negatively affects the environment, reduces the yield of entomophilous crops, and decreases the overall productivity of the sector. Researchers note that in recent years, the parasite *Varroa destructor* Anderson and Trueman, 2000 has been one of the most dangerous pests of the honey bee *Apis mellifera* Linnaeus, 1758 (De Guzman & Rinderer, 1999; Boecking & Genersch, 2008; Akimov & Korzh, 2012; Lee et al., 2018).

The spread of *Varroa* mites through the natural phenomenon of drifting bees and their movement from one colony to another, or from one apiary to another, depends on the density of colonies as well as the climatic conditions of the

region. The mite spreads faster in lowland areas than in mountainous zones. The presence of wild colonies in a territory (migratory beekeeping) is also a factor influencing the rate of spread of the varroosis-causing agent. Transmission of mites from infected bees to healthy ones may also occur through contact with the flowers of plants (Kraus & Page, 1995; Boecking & Genersch, 2008; Dahle, 2010; Delaney et al., 2011).

Long-term studies by domestic and foreign researchers have shown that varroosis is the most widespread acarine infestation of honey bees, *Apis mellifera* Linnaeus, 1758, and may develop into a panzootic, spreading to all regions of the world where these insects can live. (Aydin et al., 2007; Le Conte et al., 2010; Rinkevich et al., 2017; Yevstafieva et al., 2020).

According to studies by various authors, two species of parasitic mites, *Acarapis woodi* and *Varroa jacobsoni*, introduced into the United States in the early 1980s, significantly

changed beekeeping, causing epidemic losses of 25–80 % of bee colonies (Finley et al., 1996).

Scientific studies have demonstrated a low level of *Varroa* mite infestation of queen brood. In particular, the average infestation rate of worker brood was 48 times higher than the infestation rate of queen cells. According to researchers, this is due to royal jelly's activity, which has a detrimental effect on the causative agent of varroosis (Calderone et al., 2002; Drijfhout et al., 2005). It has also been established that during May–June, the winter generation of female mites is replaced by a new one. The mass development of *Varroa* mites occurs in summer, which coincides with bee swarming. Although adult bees leaving the swarm carry away part of the mites, about 65 % of the mites remain in the sealed brood of the parent colony. Within a short period, this proportion balances again as the queen that leaves with the swarm begins egg laying, allowing the mites to reproduce again (Delaplane et al., 2005; Harbo & Harris, 2005; Ruffinengo et al., 2014).

Therefore, timely and effective diagnosis of varroosis in honey bees will help prevent mass colony mortality and enable the application of effective therapeutic and preventive measures, making this research area highly relevant.

The study aimed to determine the effectiveness of known laboratory diagnostic methods for varroosis in honey bees.

2. Materials and methods

The study was conducted during 2024–2025 at the Laboratory of Parasitology of Poltava State Agrarian University and in private apiaries in the Poltava region.

To determine the effectiveness of known laboratory diagnostic methods for varroosis of honey bees, identical samples of bee debris (dead bees, “podmor”) were collected from affected bee colonies (Fig. 1).



Fig. 1. Sample of dead bees used to test the effectiveness of diagnostic methods for varroosis

The collected samples were examined using three different methods:

1. Boiling water method. The principle of this method consists of pouring hot water (approximately 200 ml per sample) over the test material placed in a glass container, followed by mixing. As a result, the mites settle at the bottom of the container (Crane, 1979).

2. Visual inspection method. This method involves a careful examination of the bee sample previously placed on a clean white sheet of paper. During the examination, debris is removed with tweezers, and the presence of parasites is determined (Dietemann et al., 2013).

3. Sunflower oil method. For this method, the sample of bee debris is sieved through a sieve with a mesh size of no more than 4 mm, which allows separation of bee corpses. The sifted material is transferred to a glass container, mixed with sunflower oil at a 1:10 ratio, and left for 5 minutes. During this time, the mites float to the surface, while debris settles to the bottom (Yevstafieva et al., 2021).

In total, 21 samples of bee debris were examined.

In addition, methods for detecting *Varroa* mites during the examination of live bees were compared:

1. Visual inspection method. This method involves visual examination of live insects directly in the hive and counting the mites present on them (Fakhimzadeh et al., 2011).

2. Powdered sugar method. For this method, a sample of live bees is placed into a glass container containing powdered sugar, covered with a lid, and thoroughly shaken. After that, a white sheet of paper is placed on the honeycombs, and the contents are poured out. The powdered sugar containing the mites is then examined (Santana et al., 2014).

A total of 32 samples of live bees were examined.

The mathematical analysis of the obtained data was performed in Microsoft Excel using the arithmetic mean (M) and the standard error of the mean (m).

3. Results and discussion

According to the results of the laboratory examination of dead bees (bee debris), both the boiling water method and the sunflower oil method demonstrated 100 % sensitivity. The visual detection method for mites in bee debris proved less sensitive, with 85.7 % sensitivity (Fig. 2).

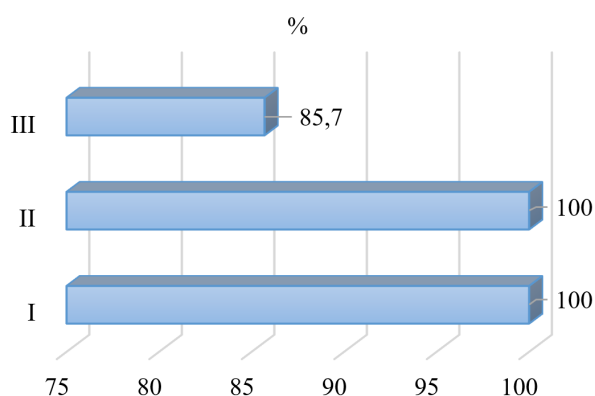


Fig. 2. Sensitivity of methods for detecting *Varroa destructor* mites during the examination of bee debris: I – boiling water method; II – sunflower oil method; III – visual detection method

The most effective laboratory diagnostic methods for varroosis in honey bees, based on the number of mites detected in bee debris, were also the boiling water method (Fig. 3) and the sunflower oil method (Fig. 4). The visual detection method of mites was found to be less effective (Fig. 5).

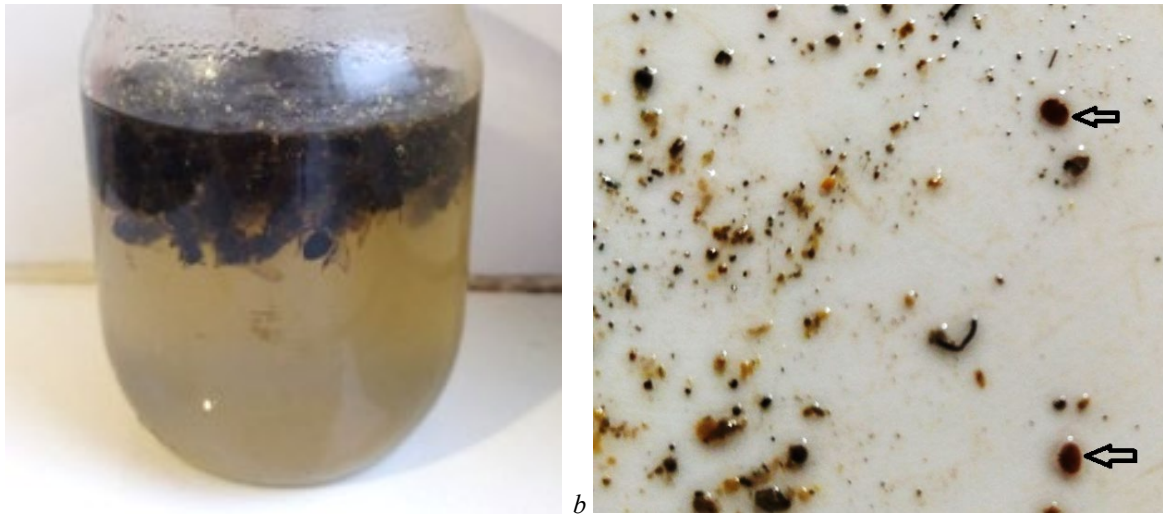


Fig. 3. Examination of bee debris using the boiling water method: *a* – glass container with bee debris filled with hot water; *b* – *Varroa* mites detected in the sediment

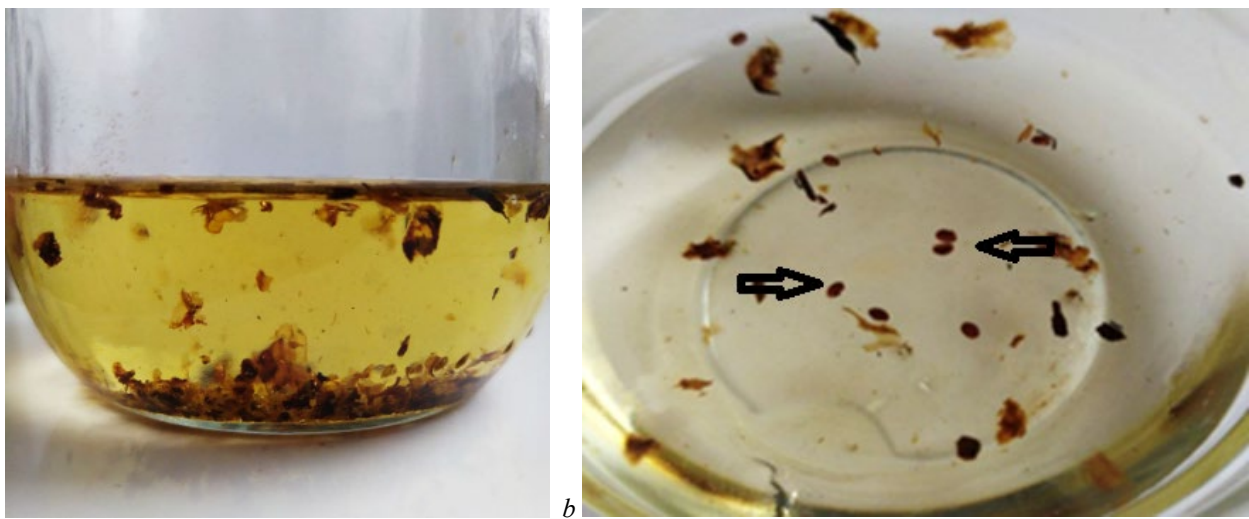


Fig. 4. Examination of bee debris using the sunflower oil method: *a* – glass container with bee debris filled with sunflower oil; *b* – detected *Varroa* mites



Fig. 5. Detection of *Varroa* mites in bee debris using the visual inspection method

In particular, when using the boiling water method, 5.6 ± 0.6 mites were detected (ranging from 4 to 8), whereas the sunflower oil method detected 5.9 ± 0.5 mites (ranging from 5 to 8). A smaller number of mites was detected using the visual detection method, namely 3.1 ± 0.6 specimens (ranging from 3 to 4 specimens) (Table 1).

Table 1

Effectiveness of methods for detecting *Varroa destructor* mites during the examination of bee debris

Method of examination	Number of detected mites specimens per sample		
	min	max	M ± m
Boiling water method	4	8	5.6 ± 0.6
Visual detection method	3	4	3.1 ± 0.6
Sunflower oil method	5	8	5.9 ± 0.5

According to the examination of live bee samples, the powdered sugar method proved to be the most sensitive (100.0 %). The visual inspection method of bees showed lower sensitivity (75.0 %) (Fig. 6).

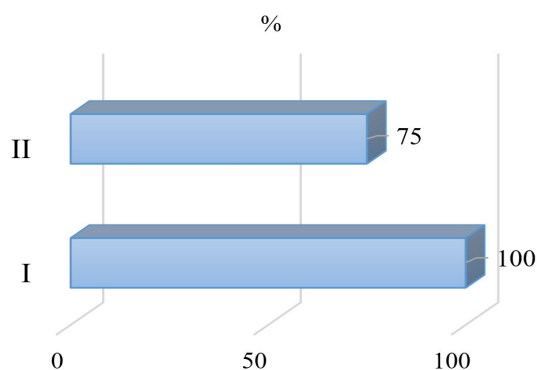


Fig. 6. Sensitivity of methods for detecting *Varroa destructor* mites during the examination of live bees: I – powdered sugar method; II – visual inspection method

The most effective laboratory diagnostic method for varroosis in honey bees, based on the number of mites detected in samples of live bees, was the powdered sugar method, which detected 13.1 ± 1.5 specimens (with a range from 4 to 23 specimens) (Table 2).

Table 2

Effectiveness of methods for detecting *Varroa destructor* mites during the examination of live bees

Method of examination	Number of detected mites specimens per sample		
	min	max	M ± m
Powdered sugar method	4	23	13.1 ± 1.5
Visual inspection method	2	16	9.5 ± 1.2

A smaller number of mites was detected using the visual inspection method for bees, namely 9.5 ± 1.2 specimens (range 2–16) (Fig. 7).



Fig. 7. Detection of *Varroa* mites on live bees using the visual inspection method

Scientific literature reports that laboratory diagnosis of varroosis is based on detecting mites in bee colonies using various methods that differ in efficiency and sensitivity (Crane, 1979; Fakhimzadeh et al., 2011; Dietemann et al., 2013; Yevstafieva et al., 2021). Therefore, our study aimed to determine the effectiveness of known laboratory diagnostic methods for varroosis in honey bees.

The conducted studies on bee debris (dead bees) revealed a high sensitivity of the boiling water and sunflower oil methods (100.0 %). The visual detection method for mites in bee debris showed lower sensitivity (85.7 %). Based on the number of detected mites in bee debris, the most effective methods were also the boiling water method (5.6 ± 0.6 specimens) and the sunflower oil method (5.9 ± 0.5 specimens). Fewer mites were detected using the visual detection method (3.1 ± 0.6 specimens).

High sensitivity and efficiency in the examination of live bees were observed with the powdered sugar method (100.0 % and 13.1 ± 1.5 specimens). Lower sensitivity and effectiveness were demonstrated by the visual inspection method for bees (75.0 % and 9.5 ± 1.2 specimens, respectively).

The high effectiveness of the powdered sugar technique applied to live bees during varroosis diagnosis is also confirmed by scientific studies. Researchers have reported that the average efficiency of this method for removing mites from adult honey bees in a warm, humid environment is about 66 %. In contrast, under cooler, drier conditions, it reaches 94 % (Gregorc et al., 2017).

There are also reports indicating that the traditional method of detecting *Varroa* mites through visual inspection of a bee colony is labor-intensive, ineffective, and may cause stress in honey bees. Moreover, this technique is considered highly unreliable for providing accurate and timely assessments of *Varroa* mite infestation levels (Fakhimzadeh et al., 2011).

The results of this research allow us to recommend the most effective methods for improving the efficiency of varroosis diagnosis in honey bees.

4. Conclusions

A 100 % sensitivity was established for the methods used to examine bee debris for the presence of *Varroa destructor* mites when applying the boiling water and sunflower oil methods, as well as for the examination of live bees using the powdered sugar method. The average number of detected mites using these methods was 5.6 ± 0.6 , 5.9 ± 0.5 , and 13.1 ± 1.5 specimens, respectively. Lower sensitivity and effectiveness were observed for the visual detection methods for mites in bee debris and on live bees (85.7 % and 75.0 %, respectively). The number of detected mites in bee debris using the visual method was 3.1 ± 0.6 specimens, whereas during the visual inspection of bees, it was 9.5 ± 1.2 specimens.

Conflict of interest

The authors declare no conflict of interest.

References

- Akimov, I. A., & Korzh, O. P. (2012). Ecological characteristics of *Varroa destructor* (Parasitiformes, Varroidea) and its environmental capacity as a key factor for the development of varroosis panzootia. *Vestnik Zoologii*, 46(5), 8–14. [\[Abstract\]](#) [\[Google Scholar\]](#)
- Aydın, L., Güleğen, E., Çakmak, İ., & Girişgin, A. O. (2007). The occurrence of *Varroa destructor* Anderson and Trueman, 2000 on honey bees (*Apis mellifera*) in Turkey. *Turkish Journal of Veterinary & Animal Sciences*, 31(3), 189–191. [\[Abstract\]](#) [\[Google Scholar\]](#)

- Boecking, O., & Genersch, E. (2008). Varroosis – the ongoing crisis in beekeeping. *Journal Für Verbraucherschutz Und Lebensmittelsicherheit*, 3(2), 221–228.
[Crossref] [Google Scholar]
- Calderone, N. W., Lin, S., & Kuenen, L. P. S. (2002). Differential infestation of honey bee, *Apis mellifera*, worker and queen brood by the parasitic mite *Varroa destructor*. *Apidologie*, 33(4), 389–398.
[Crossref] [Google Scholar]
- Crane, E. (1979). The varroa mite. *Bee World*, 59(4), 164–167.
- Dahle, B. (2010). The role of *Varroa destructor* for honey bee colony losses in Norway. *Journal of Apicultural Research*, 49(1), 124–125.
[Crossref] [Google Scholar]
- De Guzman, L. I., & Rinderer, T. E. (1999). Identification and comparison of Varroa species infesting honey bees. *Apidologie*, 30(2–3), 85–95.
[Crossref] [Google Scholar]
- Delaney, D. A., Keller, J. J., Caren, J. R., & Tarry, D. R. (2011). The physical, insemination, and reproductive quality of honey bee queens (*Apis mellifera* L.). *Apidologie*, 42(1), 1–13.
[Crossref] [Google Scholar]
- Delaplane, K. S., Berry, J. A., Skinner, J. A., Parkman, J. P., & Hood, W. M. (2005). Integrated pest management against *Varroa destructor* reduces colony mite levels and delays treatment threshold. *Journal of Apicultural Research*, 44(4), 157–162.
[Crossref] [Google Scholar]
- Dietemann, V., Nazzi, F., Martin, S. J., Anderson, D. L., Locke, B., Delaplane, K. S., Wauquiez, Q., Tannahill, C., Frey, E., Ziegelmann, B., Rosenkranz, P., & Ellis, J. D. (2013). Standard methods for varroa research. *Journal of Apicultural Research*, 52(1), 1–54.
[Crossref] [Google Scholar]
- Drijfhout, F. P., Kochansky, J., Lin, S., & Calderone, N. W. (2005). Components of honeybee royal jelly as deterrents of the parasitic varroa mite, *Varroa destructor*. *Journal of Chemical Ecology*, 31(8), 1747–1764.
[Crossref] [Google Scholar]
- Fakhimzadeh, K., Ellis, J. D., & Hayes, J. W. (2011). Physical control of varroa mites (*Varroa destructor*): the effects of various dust materials on varroa mite fall from adult honey bees (*Apis mellifera*) *in vitro*. *Journal of Apicultural Research*, 50(3), 203–211.
[Crossref] [Google Scholar]
- Finley, J., Camazine, S., & Frazier, M. (1996). The epidemic of honey bee colony losses during the 1995–1996 season. *American Bee Journal*, 136(11), 805–808.
[Abstract] [Google Scholar]
- Gregorc, A., Alburaki, M., Werle, C., Knight, P. R., & Adamczyk, J. (2017). Brood removal or queen caging combined with oxalic acid treatment to control varroa mites (*Varroa destructor*) in honey bee colonies (*Apis mellifera*). *Apidologie*, 48(6), 821–832.
[Crossref] [Google Scholar]
- Harbo, J. R., & Harris, J. W. (2005). Suppressed mite reproduction explained by the behaviour of adult bees. *Journal of Apicultural Research*, 44(1), 21–23.
[Crossref] [Google Scholar]
- Kraus, B., & Page, R. E. (1995). Effect of *Varroa jacobsoni* (Mesostigmata: Varroidae) on feral *Apis mellifera* (Hymenoptera: Apidae) in California. *Environmental Entomology*, 24(6), 1473–1480.
[Crossref] [Google Scholar]
- Le Conte, Y., Ellis, M., & Ritter, W. (2010). Varroa mites and honey bee health: can Varroa explain part of the colony losses? *Apidologie*, 41(3), 353–363.
[Crossref] [Google Scholar]
- Lee, H., Sumner, D. A., & Champetier, A. (2018). Pollination markets and the coupled futures of almonds and honey bees: Simulating impacts of shifts in demands and costs. *American Journal of Agricultural Economics*, 101(1), 230–249.
[Crossref] [Google Scholar]
- Rinkevich, F., Danka, R., & Healy, K. (2017). Influence of varroa mite (*Varroa destructor*) management practices on insecticide sensitivity in the honey bee (*Apis mellifera*). *Insects*, 8(1), 9.
[Crossref] [Google Scholar]
- Ruffinengo, R. S., Maggi, M. D., Fuselli, S., Fiorella, G., Negri, P., Brascesco, C., Satta, A., Floris, I., & Eguaras, M. J. (2014). Bioactivity of microencapsulated essential oils and perspectives of their use in the control of Varroa destructor. *Bulletin of Insectology*, 67(1), 81–86.
[Abstract] [Google Scholar]
- Santana, F. S., Costa, A. H. R., Truzzi, F. S., Silva, F. L., Santos, S. L., Franco, T. M., & Saraiva, A. M. (2014). A reference process for automating bee species identification based on wing images and digital image processing. *Ecological Informatics*, 24, 248–260.
[Crossref] [Google Scholar]
- Yevstafieva, V. O., Melnychuk, V. V., & Nazarenko, O. S. (2021). *Varoos medonosnykh bdzhil: monohrafiia [Varroosis of honey bees: monograph]*. Poltava: Astraya (in Ukrainian).
- Yevstafieva, V. O., Zaloznaya, L. M., Nazarenko, O. S., Melnychuk, V. V., & Sobolta, A. G. (2020). Morphological variation of *Varroa destructor* (Parasitiformes, Varroidae) in different seasons. *Biosystems Diversity*, 28(1), 18–23.
[Crossref] [Google Scholar]