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Risk analysis of *Apis mellifera* colony losses and health assessment in Albania from 2021 to 2023

Kastriot Korro*

Associated Professor, Lecturer
Agricultural University of Tirana
1025, Paisi Vodica Str., Tirana, Albania
<https://orcid.org/0000-0002-9304-1041>

Vitor Malutaj

President of the Federation
Federation of Beekeepers of Albania
1001, Muhamet Deliu Str., Tirana, Albania
Lecturer
Agricultural University of Tirana
1025, Paisi Vodica Str., Tirana, Albania
<https://orcid.org/0009-0004-7462-4577>

Gani Moka

Professor, Lecturer
Agricultural University of Tirana
1025, Paisi Vodica Str., Tirana, Albania
<https://orcid.org/0009-0005-5991-838X>

Merije Elezi

Associated Professor, Lecturer
University of Tetova
1200, Ilinden Str., Tetova, Republic of North Macedonia
<https://orcid.org/0000-0002-5073-2483>

Besnik Elezi

Associated Professor, Lecturer
University of Tetova
1200, Ilinden Str., Tetova, Republic of North Macedonia
<https://orcid.org/0009-0008-7867-9187>

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Abstract. The research relevance is determined by the decline of bee populations in Albania, as the need to understand the dynamics of colony loss and the factors contributing to it is of paramount importance. The study aimed to comprehensively investigate the prevalence and main causes of colony losses, with special attention to

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*Corresponding author

Varroa mite infestation, *Nosema* disease, viral pathogens, pesticides, and bacterial infections. Using the stratified sampling method, 15,493 beekeepers of different ages and experiences participated in the study. Both electronic and face-to-face surveys were used to collect data on bee family losses, management practices and environmental factors affecting bee health. In addition, monitoring programmes allowed a detailed assessment of bee family health and environmental conditions in the apiary, providing valuable information on temporal trends and patterns. The findings indicate alarming rates of *Varroa* mite infestation, prevalence of *Nosema* and a complex interplay of factors contributing to colony loss, particularly during the summer and winter months. For example, *Varroa* mite infestation was found in 61% of the 29,474 bee samples collected during summer sampling, with rates ranging from 0.5% to 70.2%. Similarly, during autumn sampling, 65% of 43,037 bee samples contained *Varroa* mites, with an average infestation rate of 5.3%. Moreover, *Nosema* disease is also a complex problem, with clinical prevalence ranging from 0.1% in autumn to 1.3% in summer and spring. These key figures highlight the urgent need to develop effective strategies to reduce *Varroa* mite infestation and *Nosema* disease, thereby maintaining bee populations and ecosystem health. The results of the study make a valuable contribution to bee management and policy development, emphasising the importance of holistic approaches to maintaining bee health and resilience in Albania

Keywords: varroaosis; winter losses; *Nosema*; queen; seasonal diseases

INTRODUCTION

Bees are crucial to pollination, ecosystem health and food production. Understanding the factors contributing to bee colony loss is critical to protecting bee populations and ensuring global food security. The research problem revolves around the increasing rates of colony loss observed in *Apis mellifera* populations, particularly in Albania, and the complex interplay of factors such as *Varroa* mite infestation, *Nosema*, viral pathogens, pesticides and bacterial infections contributing to these losses. Understanding the specific dynamics of bee family health and the cause of deterioration is paramount to implementing effective mitigation strategies and conserving bee populations.

D. Pavlova *et al.* (2022) concluded that honeybees pollinate about 35% of the world's crops. According to authors plant pollination by honeybees provides an efficient mechanism for seed formation and hence for the maintenance of biodiversity. This utility provided by bees has a cascading effect on the food chain, ensuring the yield and quality of many crops. In addition to their role in pollination, S. Lippi and M. Sanfilippo (2023), identify the production of valuable products by honey bees. In her opinion, honey, as a result of beekeeping, not only serves as a source of nutrients but also has applications in medical practice and other human activities.

Beekeeping in Albania is a long-standing and traditional industry. According to the Food and Agriculture Organisation, as of 2022, there were about 100,000 beekeepers in Albania, managing approximately 1.5 million bee families (FAO partners with Albania..., 2023). These figures reflect the significant spread and importance of beekeeping in rural and peri-urban areas of Albania. Beekeeping is not only a source of income for many families but also plays a key role in maintaining the ecosystem, pollinating plants, and producing valuable bee products such as honey and other products (Tyliszczak *et al.*, 2017).

M. Kuliçi (2021b) notes the significant contribution of *Apis mellifera* bees to agricultural production and biodiversity conservation in Albania. The studies emphasise that the activities of these bees contribute to the pollination process of different crops, which leads to increased yields of fruits, as well as important crops such as wheat, maize, and vegetables. The role of bees in maintaining biodiversity by pollinating wildflowers has also received special attention. This process not only favours the formation of new generations of plants but also ensures the preservation of Albania's natural ecosystem.

The statement of B. Bekić Šarić *et al.* (2023) on the effect of bee population reduction on crop yields is confirmed by numerous scientific studies. The researchers suggest that this problem may lead to higher food prices and lower economic activity in the agricultural sector. Moreover, studies show that insufficient pollination can also affect the quality of the crop, affecting the size, shape and maturity of fruits and seeds. This can negatively affect the profitability and competitiveness of agricultural production. M. Kuliçi (2021a) notes the additional problem of possible increased production costs for farmers who depend on bees to pollinate their crops. This problem becomes relevant when bee populations are reduced or unavailable for pollination. If bees are not available for pollination, farmers may be forced to seek alternative pollination methods such as hand pollination or the use of other insect pollinators (Kuzbakova *et al.*, 2022). These methods can be more labour-intensive and costly than natural pollination by bees.

Despite the rather extensive views of researchers, their studies lack more specific and relevant information on the situation of colony loss risk analysis, statistical information on this topic, as well as a more detailed assessment of the health and diseases of honey bee families. Based on the aforementioned, the study aims to assess the current status of the honey bee population in Albania, to analyse the factors affecting the

decline in their numbers, and to develop recommendations to reduce the risks of loss of *Apis mellifera* colonies in this country.

MATERIALS AND METHODS

In conducting the survey and monitoring of apiaries across Albania between 2021 and 2023, a stratified sampling approach was used to ensure representation of the different beekeeping communities. Working with the Association of Beekeepers, public institutions and local communities, efforts were made to recruit 15,493 beekeepers of different ages (22-75 years) and experience levels (3-58 years). Survey questionnaires were distributed through both electronic and in-person distribution channels to gain insight into bee family losses, management practices, and environmental factors affecting bee health. Face-to-face interviews conducted by field teams facilitated deeper engagement with beekeepers, allowing qualitative data and first-hand observations to be collected on beekeeping practices and challenges faced in different regions.

In addition, monitoring programmes were established in collaboration with local beekeepers' associations and extension services to assess bee family health and environmental conditions at apiaries. Trained staff made field visits to apiaries four times a year, where they systematically assessed bee family health, recorded bee family counts, and identified potential stressors affecting bee populations. Data collected during surveys and monitoring activities were systematically analysed to identify trends, patterns and correlations related to family loss and beekeeping practices. Ethical considerations, including informed consent and data confidentiality, were prioritised throughout the research process to ensure the integrity and privacy of participants. Through this integrated approach, the study aimed to provide science-based insights and recommendations to promote sustainable beekeeping practices and improve bee family health throughout Albania.

Univariate analyses were performed to assess the relationship between modifying factors and colony losses in summer/winter. Statistical methods were used to quantify the effects of *Varroa* mites, parasites of the genus *Nosema*, colony characteristics and queen health on colony losses in different periods. seasons. These analyses provided detailed information on the relative importance of different factors affecting colony health dynamics.

Various methods of data collection and analysis were used, including official reports, surveys, statistical software, and review of research literature. Baseline data were obtained from reports of the Albanian Ministry of Agriculture, European and International beekeeping organisations, and through questionnaires distributed to beekeepers to collect information on management practices, bee diseases and pesticide use. Statistical software R was used to analyse the collected data. These methods were selected due to their suitability for the study objectives and to reflect the multifaceted nature of bee family health and losses. A longitudinal observational study allowed the examination of temporal trends and patterns, while univariate analyses allowed the identification of specific factors contributing to colony collapse disorder in different seasons. Survey-based data collection ensured that the diverse perspectives of beekeepers and stakeholders were considered, thus enhancing the comprehensiveness and relevance of the research findings. The research was conducted in accordance with the rules of The Declaration of Helsinki (2013).

RESULTS

A study conducted with the University of Tirana shows a marked increase in the number of bee families in Albania between 2021 and 2023. In 2021, 298,000 bee families were registered, which in itself is a significant indicator for the country's agricultural sector, especially given the importance of bees in pollination and honey production (Table 1).

Table 1. Number of bee families in Albania from 2021 to 2023

No.	Year	Bee families
1	2021	298,000
2	2022	320,000
3	2023	360,000

Source: compiled by the authors

By 2022, a growth of 7.38% is observed, reaching the 320,000 bee families mark. This increase can be attributed to improved conditions for beekeeping, the introduction of more advanced technologies and methods of bee care, and the growing interest in beekeeping as a sustainable and profitable agricultural activity. A notable jump occurred in 2023, when the number of bee families increased to 360,000, up 12.5% from the previous year. This growth can be attributed not only to

internal factors, such as improved beekeeping practices and expansion of apiary areas but also to external factors, such as increased demand for honey and other bee products in both domestic and foreign markets. Analyses of colony health show that approximately 60% of colonies tested were of normal size and viability. Conversely, only 12% of colonies were categorised as particularly weak, while 18% were found to be exceptionally resilient. Interestingly, among this 12% subset

of weakened colonies, signs of potential collapse were evident during the autumn season. The main causes of this dangerous condition are various factors, particularly cases of uterine mortality, the introduction of a new uterus, the establishment of new families, and clinical signs of varroosis and nosemosis. Varroosis has emerged as the predominant parasitic disease, with 42,494 clinical observations recorded during the field visits. Consequently, the clinical prevalence of varroosis in the sampled apiaries was an alarming 66%.

Analyses of families experiencing summer losses show clear patterns: lack of mothers and *Varroa* mite infestation become important risk factors. When closely examined in July, typical families struggling with summer losses tended to be either motherless or affected by varying degrees of *Varroa* mite infestation, as shown in Table 2. Despite the infrequency of summer losses, only 3,600 cases were observed among the 3,600,000 families, the model Consideration of these cases sheds light on critical risk factors affecting colony health.

Table 2. Bee family losses in Albania by year and season

Period	Spring*	%	Summer*	%	Autumn*	%	Winter*	%	Overall	% ¹
2021	13,708	20	3,427	5	10,281	15	41,124	60	68,540	23
2022	12,642	18	3,529	5	10,560	15	43,648	62	70,379	22
2023	15,840	22	3,600	5	8,640	12	43,920	61	72,000	20
Overall	42,190		10,556		29,481		128,692		210,919	

Note: * – number of dead families at a particular time of year; ¹ – percentage of all bee families in Albania in a particular year

Source: compiled by the authors

The relatively low probability of summer losses kept the modelled probability around 5% for all identified risk factors. However, the absence of a queen significantly increased the probability of summer loss, increasing the probability by a factor of about 54 compared to families with intact mates. For families equipped with mates, the probability of summer loss mortality hovered around 0.2% under average conditions. Conversely, families deprived of mates experienced a significantly higher probability of summer mortality, as high as 3.2%. Moreover, colony strength emerged as a key determinant of summer survival: weaker colonies experienced a staggering 25-fold increase in the probability of summer mortality compared to their stronger counterparts. Notably, the size of colonies, both normal and resistant, showed no significant differences in the probability of summer mortality.

The effect of *Varroa* mite infestation on summer losses requires close attention, as the model predicts a gradual increase in summer mortality as mite levels increase. Specifically, for every 2% increase in *Varroa* mite infestation, the probability of summer mortality increased by a factor of 2.37. Notably, the model predictions identify a summer loss probability of 0.93% when *Varroa* mite infestation levels reach 30%, with all other covariates remaining at average levels. These results emphasise the complex interplay of factors affecting colony health during the summer months. By elucidating the subtle relationships between queen status, bee family vigour, *Varroa* mite infestation and summer losses, beekeepers can proactively implement targeted management strategies to improve bee family resilience and prevent the detrimental effects of these risk factors. Through vigilant monitoring and adaptive intervention, beekeepers can strive to maintain healthy

and thriving families, ensuring the long-term sustainability of bee populations in the face of changing environmental challenges.

The number of colony losses increased markedly during the winter months, especially when colonies were managed by queens that had reached the yearling mark. This observation highlights the disturbing trend that older queen mothers over a year old develop a range of physiological disorders that have a detrimental effect on colony development and overall health. Research suggests that as queens age, they may be prone to certain physiological abnormalities that interfere with optimal colony function and sustainability. Indeed, the presence of older mothers correlates with a cascade of adverse effects, including reduced productivity and a propensity for smaller colony sizes, both of which are often cited as precursors to colony mortality. The complex relationship between queen age and family health emphasises the key role that queen viability plays in maintaining family dynamics and longevity during the challenging winter season (Bruckner et al., 2023).

The mechanisms underlying the detrimental effects of older queen mothers on family health are multifaceted. Physiological changes associated with ageing can compromise a queen's ability to maintain reproductive vigour and effectively regulate colony dynamics. As a result, colonies headed by older queen mothers may experience reduced brood production, reduced feeding efficiency and increased susceptibility to environmental stressors. Moreover, the link between queen senescence and declining productivity highlights the complex social dynamics within bee families. Worker bees rely heavily on signals and pheromonal cues emitted by the queen to coordinate their activities and maintain family cohesion.

In the presence of an older queen, these regulatory mechanisms may be disrupted, leading to suboptimal colony functioning and increased vulnerability to unfavourable environmental conditions (Table 3).

Table 3. Review of the results of univariate analyses of factors associated with summer and winter losses

Parameter	Modifying factor	Summer losses	Winter losses
Summer diseases	Nosemite parasite	-	-
	<i>Varroa</i> mite	↑	↑
Winter diseases	Nosemite parasite	-	↑
	<i>Varroa</i> mite ↑		↑
Bee colony characteristics	Spring nest colony	-	↓
	Migrating colony	-	-
	Summer-weakened colony	↑	-
	Winter-weakened colony	-	↑
	Non-summer-active queen	↑	-
	Non-winter-active queen	-	↑
	Old-at-summer queen	↑	↑
	Old-at-winter queen	↑	↑

Note: "↑" – defines a marked increase in the probability of colony loss when the factor is applied; "↓" – defines a significant decrease in the probability of colony loss; "-" – indicates a negligible effect on the probability of colony loss

Source: compiled by the authors

The bee families surveyed in Albania remained healthy throughout the study period. Visible clinical symptoms of only two diseases were observed in about 12.8% of apiaries. Varroosis became the predominant disease, consistently occurring in families and correlating with losses in both summer and winter. The causes of colony losses in late summer and winter appeared to be similar, often related to the general weakness of each colony. Varroosis was one and a half times more frequent in late summer and autumn than in spring. Nosemosis was recorded in 15,120 colonies from different apiaries and confirmed by laboratory analyses at the Laboratory of Wild Animals and Bees at the Agricultural University of Tirana. Its clinical prevalence varied from 3% in autumn to 5% in summer and spring. During visits, dead bees were found in front of the colony, as well as signs of diarrhoea. The queen is one of the most important factors in assessing the probability of loss in both summer

and winter. A colony has a higher risk of summer loss if it is left without a queen in July. This indicates that the timing of queen replacement is a very sensitive phase in colony development. Loss of a queen during mating flight or hive manipulation, failed mating, introduction of a weak or sick queen and rejection of the new queen by worker bees are some of the problems faced by beekeepers.

When analysing the table of family losses by cause, it is evident that Varroatoxis appears to be the main culprit, highlighting its widespread impact on bee families (Table 4). The ubiquitous presence of *Varroa* mites, clinically observed by vigilant beekeepers or veterinary specialists during routine inspections, emphasises the severity of the infestation. In addition, confirmation of *Varroa* mite infestation through laboratory analyses performed in local, regional, or national laboratories confirms its role as a significant factor in bee mortality in affected families.

Table 4. Percentage of bee family losses by cause of loss

Cause	Number of dead bee families in 2021	Number of bee families lost per 2022	Number of bee families lost per 2023	Overall values
Varroatoxis	65%	69%	64%	66%
Nosematosis	20%	15%	21%	19%
Pesticides	-	-	-	-
Viruses (Wing deformation Virus (WDV))	10%	10%	12%	10%
Bacterial diseases	-	-	-	-
Fungal diseases (Ascospheerosis and Aspergillois)	2%	2%	2%	2%
Other causes (damage from bears, traffic, landslides, flooding, rainstorms)	3%	4%	51%	3%
Overall	100%	100%	100%	100%

Source: compiled by the authors

In the study, researchers collected bee samples during both the summer and autumn seasons to assess the prevalence of *Varroa* mite infestation in families. In summer sampling, *Varroa* mites were detected in 61% of the 29,474 bee samples collected, indicating a high rate of infestation. These rates varied considerably, from 0.5% to an astounding 70.2%. As the season moved into autumn, the presence of *Varroa* mites remained at similar levels, with 65% of 43,037 bee samples containing these parasitic mites. The average infestation rate for this period was 5.3%, showing a wider range of infestation levels, from 0.9% to approximately 92.8%. Notably, the highest recorded infestation level of 92.8% was recorded in an apiary heavily affected by *Varroa* infestation, where the average autumn infestation level reached 22.7%.

The discovery that half of the colonies had already died of *Varroa* infestation at the time of sampling and most of the remaining colonies suffered the same fate in the following months was of great concern. This grim reality emphasises the detrimental impact of *Varroa* mites on honey bee families. It is important to note that the absence of *Varroa* mites in a sample does not necessarily guarantee the absence of infestation within a family. Nevertheless, detailed analysis revealed a clear correlation between the presence of *Varroa* mites and colonies diagnosed with varroosis. Colonies affected by *Varroa* mites had six times higher rates of *Varroa* infestation than colonies without a diagnosis. For instance, during summer sampling, families without varroosis had an average infection rate of 18.4%, while families diagnosed with varroosis had a much higher rate of 22.5%. Similarly, during autumn sampling, families without varroosis had an average infection rate of 20.1%, in stark contrast to the 34.6% rate observed in families diagnosed with varroosis. These results emphasise the urgent need for effective strategies to control *Varroa* mite infestations and mitigate their devastating effects on honey bee populations.

The presence of *Nosema* disease is a complex problem in beekeeping. Clinical prevalence ranged from 0.1% in autumn to 1.3% in both summer and spring, showing no significant differences between the four visits. Bee inspectors documented various symptoms including bee deaths in front of the family (469 cases), signs of diarrhoea (6,983 cases), bee deaths combined with diarrhoea (996 cases) and non-flying bees near the family (1,352 cases). Analysis was carried out on 2,947 cases using dead bees as matrix and 7,251 samples included faecal samples. Among these samples, 5,728 were infested with *Nosematosis*. However, the presence of *Varroa* mites in almost all cases makes it difficult to determine the primary cause of bee mortality. This coincidence blurs the distinction between *Varroa* and *Nosema*, emphasising the interrelated nature of bee health problems.

The lack of diagnostic tools for viral diseases in Albania is a particular problem. Diagnosis, especially of wing deformity virus-WDV, is based solely on visible

clinical signs. Unfortunately, the lack of diagnostic facilities limits a comprehensive understanding of viral diseases affecting bee families, resulting in many viral pathogens remaining undiagnosed and their impact underestimated. Although pesticides and bacterial diseases have deleterious effects on bee populations, their effects are different in nature. Unlike Varroosis and *Nosema*, which can wipe out entire families, pesticide exposure and bacterial infections usually result in reduced bee numbers and productivity rather than total mortality. Consequently, they are not listed in the loss table, although their impact on colony health and productivity should not be overlooked. The complex nature of bee losses emphasises the complexities of beekeeping and the challenges associated with maintaining healthy and thriving families. Effective mitigation strategies require a holistic approach that considers the interactions of *Varroa* mites, *Nosema*, viral pathogens, pesticides, and bacterial infections, protecting bee populations and preserving their vital role in both ecosystems and agricultural systems.

DISCUSSION

The results of the present study emphasise the importance of winter as a critical season for colony mortality in Albania. In the study, 73% of all family losses occurred during winter. This trend mirrors observations in other European countries. A study conducted by V.R. Olate-Olave *et al.* (2021), in Norway, found a comparable ratio of losses between summer and winter, with 75.3% of losses occurring in winter 2020/2023 and 22.7% in summer 2020. An extensive study by E. Alonso-Prados *et al.* (2020), which examined summer and winter losses in 17 European countries, confirmed these findings, emphasising the highest loss rates in the winter season. However, in southern European countries, as well as in studies conducted by L. Insolia *et al.* (2022), in the USA, reported similar rates of loss for both winter and summer seasons. These differences suggest that the relative importance of winter and summer mortality varies by country and climatic region. Potential factors contributing to these differences include, among others, differences in land use practices, pesticide application rates, bee family dynamics and beekeeping methodologies.

Extensive beekeeping experience significantly reduces the probability of winter losses of bee families, as evidenced by many years of experience (Dvykaliuk *et al.*, 2023). A study by S. More *et al.* (2021) found a remarkable positive correlation between beekeeper age and winter losses. Surprisingly, their data set showed that the highest winter losses occurred among apiaries managed by older beekeepers with limited families and minimal beekeeping experience. Conversely, the study by the researchers showed that beekeepers with more experience, i.e. older beekeepers, tended to control more bee families compared to novice beekeepers. Possession of a significant number of colonies often reflects an increased level of

professionalism. Consequently, the results of both studies emphasise that European beekeepers with a high level of professionalism, demonstrated by managing numerous bee families and having extensive experience, suffered fewer losses than their colleagues with a lower level of professionalism. In the present study, additional factors such as apiary and enterprise size and a higher level of beekeeping education were considered when assessing professionalism. However, these factors either showed no correlation with losses or failed to increase the explanatory power of the model, hence excluding them from the multivariate analysis. The number of bee families managed by beekeepers often matches their goals and significantly determines their management approach. As stated by K.P. Hester *et al.* (2023), these differences may explain seasonal differences in family losses among different types of beekeepers. Similar trends have been observed in both domestic and international studies. Homestead beekeepers consistently had higher winter losses than their commercial counterparts, except for the 2021-2022 period.

A. Leska *et al.* (2021) add that many commercial beekeepers rely on their bee families as a source of income and therefore prioritise strong families at the beginning of the brood-rearing season to ensure efficient pollination services in the spring. These beekeepers are more inclined to use chemical control agents such as acaricides to control the critical biotic risk factor *Varroa*. This proactive approach potentially reduces the risk of winter mortality associated with parasite pressure; an idea echoed in recent studies. Interestingly, beekeepers unanimously identified *Varroa* as the main cause of winter losses across all three years of the study, regardless of the type of operation. This suggests that homestead beekeepers are also aware of the risks of *Varroa*, but their hesitancy to use synthetic acaricides and the timing of treatment may affect the effectiveness of their management strategies. In contrast, commercial beekeepers suffered significantly higher family losses in summer compared to other types of beekeeping operations. While they diligently care for their families in the autumn to ensure strong families in the spring, the use of in-hive acaricides, which can promote the emergence of resistant *Varroa* mites, along with exposure to agricultural chemicals, may explain the increased summer losses. Losses during the brood-rearing season are a concern and may be related to what beekeepers believe to be the main cause of summer losses – “partner problems” (Kirimbayeva *et al.*, 2023).

Studies by A. De Carolis *et al.* (2023) showed that residues of chemicals used for *Varroa* control can adversely affect the reproductive health and behaviour of partners and potential partners. Large-scale beekeeping operations, such as long-distance transport for pollination services, may expose honeybees to significant stress. However, previous results do not indicate a significant negative relationship between these activities and winter colony mortality rates. These activities likely

that either such activities are not detrimental to the family as a whole, or any negative effects are offset by subsequent hive management practices. Future research should examine the relationship between beekeepers' management activities and bee family losses to improve recommendations for best management practices. Furthermore, following L. Barascou *et al.* (2023), Polish beekeepers actively monitored and applied *Varroa* control practices and reported markedly lower rates of bee family mortality compared to their colleagues who did not engage in such practices. This observation echoes data from the United States, where the use of barricades, especially amitraz, consistently showed a positive correlation with reduced winter losses.

Similarly, a study conducted by N. Steinhauer *et al.* (2021) in Luxembourg emphasised the importance of preventive treatment of *Varroa*, highlighting the efficacy of timely treatment given during both summer and winter seasons. This strategic approach was associated with a marked reduction in colony loss. Similarly, study by K. Naharki and S. Regmi (2020), in Canada highlighted the significant impact of *Varroa* infestation on bee health: approximately 79% of winter family mortality was associated with the presence of *Varroa* mites. These collective results confirm the crucial role of *Varroa* control measures in mitigating bee family losses in different geographical regions. By actively controlling and applying effective *Varroa* control strategies, Albanian beekeepers can increase the resilience of their families and contribute to the overall health and sustainability of bee populations.

To mitigate losses and increase the resilience of bee families, M. Stanković *et al.* (2023) recommend several preventive measures. Firstly, improving the genetic quality of mothers is of paramount importance. Selecting and breeding mothers with desirable characteristics can enhance colony health and productivity over subsequent generations. In addition, efforts to reduce the occurrence of laying workers or laying mothers are critical. The presence of such individuals can disrupt colony dynamics and jeopardise overall hive productivity. Controlling Africanisation by replacing European queens is another strategy to mitigate losses. By introducing European queens into hives prone to Africanisation, beekeepers can help maintain the desired genetic and temperament traits in their families (Salyuk, 2023).

As noted by N. Capela *et al.* (2023), minimising pesticide exposure is critical to protecting bee health. This can be achieved by working with farmers to coordinate pesticide application schedules and selecting strategic locations for apiaries that reduce the risks of pesticide exposure. Moreover, it is vital to improve the diagnosis and control of varroosis and other diseases and pests. Regular monitoring, timely intervention and the use of effective treatment protocols can help mitigate the detrimental effects of disease outbreaks and pest infestations (Kołacz *et al.*, 2023).

At the national level, it is critical to promote educational initiatives and training resources for beekeepers. R. Bava *et al.* (2023) add that providing accessible and comprehensive educational materials can provide beekeepers with the knowledge and skills necessary to identify potential threats to bee family health, take preventive measures and respond effectively to problems as they arise. By fostering a culture of continuous learning and equipping beekeepers with the tools and knowledge necessary to address the multifaceted challenges faced by bee populations, a sustainable and productive beekeeping industry can be worked towards.

CONCLUSIONS

A study conducted between 2021 and 2023 in Albania has revealed serious problems related to the loss of bee families caused by various factors. Through careful data collection involving 15,493 beekeepers, the main factors causing bee family deaths at different times of the year were observed.

One of the main causes of bee family death is Varroaosis, caused by parasitic *Varroa* mites. This disease causes bees to become emaciated and reduce their ability to reproduce, eventually leading to colony collapse. In addition, Nosematosis caused by microscopic parasitic protozoa is also a significant cause of bee family loss. Symptoms of *Nosema* include diarrhoea and weight loss of the bees, leading to exhaustion and death. The third cause of bee family loss is weakness,

caused by various factors such as lack of a queen, low numbers or an ageing queen. Weak families are more susceptible to disease and more likely to die. Interestingly, bee family losses are higher in the winter months than in summer, which is explained by the fact that bees are dormant in winter and less able to resist diseases and stresses. On average, winter losses were 20%, while summer losses were only 5%. Thus, the study showed that the loss of bee families in Albania is a serious problem and measures are needed to control Varroaosis, *Nosema* and other factors threatening beekeeping in the region.

Further research on bee family loss in Albania should focus on several key aspects, including genetic resistance of bees, development of new parasite control methods, study of environmental factors, development of sustainable beekeeping practices, education and public awareness, and establishment of a monitoring and information exchange system among stakeholders. These efforts will contribute significantly to the conservation of beekeeping in the region, ensuring the sustainability of ecosystems and agricultural production in Albania and beyond.

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CONFLICT OF INTEREST

None.

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Аналіз ризиків втрати колоній *Apis mellifera* та оцінка стану здоров'я в Албанії з 2021 по 2023 рік

Кастріот Корро

Доцент, викладач

Сільськогосподарський університет Тирани
1025, вул. Паїсі Водіца, м. Тирана, Албанія
<https://orcid.org/0000-0002-9304-1041>

Вітор Малутай

Президент федерації

Федерація бджолярів Албанії

1001, вул. Мухамет Деліу, м. Тирана, Албанія
Викладач

Сільськогосподарський університет Тирани
1025, вул. Паїсі Водіца, м. Тирана, Албанія
<https://orcid.org/0009-0004-7462-4577>

Гані Мока

Професор, викладач

Сільськогосподарський університет Тирани
1025, вул. Паїсі Водіца, м. Тирана, Албанія
<https://orcid.org/0009-0005-5991-838X>

Меріє Елезі

Доцент, викладач

Університет Тетова

1200, вул. Ілнден, м. Тетова, Республіка Північна Македонія
<https://orcid.org/0000-0002-5073-2483>

Беснік Елезі

Доцент, викладач

Університет Тетова

1200, вул. Ілнден, м. Тетова, Республіка Північна Македонія
<https://orcid.org/0009-0008-7867-9187>

Анотація. Актуальність дослідження зумовлена скороченням чисельності бджолиних сімей в Албанії, оскільки необхідність розуміння динаміки втрати бджолосімей та факторів, що її спричиняють, має першочергове значення. Метою дослідження було комплексне вивчення поширеності та основних причин загибелі бджолосімей, приділяючи особливу увагу зараженню кліщем *Varroa*, нозематозу, вірусним патогенам, пестицидам та бактеріальним інфекціям. Використовуючи метод стратифікованої вибірки, у дослідженні взяли участь 15 493 бджолярі різного віку та досвіду. Для збору даних про втрати бджолиних сімей, практики управління та фактори навколишнього середовища, що впливають на здоров'я бджіл, використовувалися як електронні, так і особисті опитування. Крім того, програми моніторингу дозволили детально оцінити стан здоров'я бджолиних сімей та умови навколишнього середовища на пасіці, надавши цінну інформацію про часові тенденції та закономірності. Отримані дані свідчать про тривожні темпи зараження кліщем *Varroa*, поширеність нозематозу та складну взаємодію факторів, що призводять до втрати бджолосімей, особливо в літні та зимові місяці. Наприклад, кліщ *Varroa* був виявлений у 61 % з 29,474 зразків бджіл, відібраних під час літнього відбору проб, з показниками від 0,5 % до 70,2 %. Аналогічно, під час осіннього відбору 65 % з 43,037 зразків бджіл містили кліщів *Varroa*, а середній рівень зараження становив 5,3 %. Крім того, нозематоз також є складною проблемою, оскільки його клінічна поширеність коливається від 0,1 % восени до 1,3 % влітку та навесні. Ці ключові цифри підкреслюють нагальну потребу в розробці ефективних стратегій для зменшення зараження кліщем *Varroa* та нозематозу, тим самим підтримуючи популяції бджіл та здоров'я екосистеми. Результати дослідження є цінним внеском в управління бджільництвом та розробку політики, підкреслюючи важливість цілісних підходів до підтримки здоров'я та стійкості бджіл в Албанії

Ключові слова: вароатоз; зимові втрати; нозематоз; матка; сезонні хвороби