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A Preliminary and Multidisciplinary Study: The Effect of "Sleeping on The Beehives" and Listening to Bees on Human Anxiety Levels

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Abstract: Apihouses are specialized wooden sheds designed to promote relaxation through sensory experiences associated with beehives, such as buzzing sounds and hive air, without direct interaction with bees. While anecdotal evidence suggests calming effects of this experience, scientific validation remains limited. This preliminary study evaluates the potential anxiety-reducing effects of apihouse experiences and bee buzzing sounds. 60 participants were randomly divided into two groups: one exposed to a real apihouse environment and the other to recorded bee buzzing sounds. Anxiety levels were assessed using the State-Trait Anxiety Inventory for Adults (STAI-AD) before and after exposure. Sound analysis from the apihouse revealed peak frequencies ranging from 237 Hz to 416 Hz, with a mean of 274 Hz, consistent with non-aggressive, normal bee activity. Both groups demonstrated significant reductions in state and trait anxiety levels ($p < 0.001$), indicating that both the apihouse environment and bee buzzing sounds lead to anxiety alleviation on their own. Within its limitations, this study highlights the therapeutic potential of apihouses and sets the stage for future research to uncover their underlying mechanisms and broader applications in promoting holistic well-being. The observed reduction in anxiety levels paves the way for new research opportunities and suggests further research with a larger sample size and in a more isolated environment is necessary.

Keywords: Beehive Sound Frequency, Apitherapy, Apihouse, Ecopsychology, Holistic Well-being

INTRODUCTION

Honey bees play an important role as significant pollinators of plants, help increase crop yields, and are indispensable for production of honey and other related products [12; 20]. However, in recent years, bees have also gained a reputation for their therapeutic properties under apitherapy [5; 16; 29; 31].

Apitherapy involves the use of bee products such as honey, royal jelly, propolis, and bee venom for their medicinal and health-promoting properties. Bee products have been recognized for their antioxidant, anti-inflammatory, and immune-boosting effects and are utilized as a complementary and alternative medicine for various conditions, including arthritis, allergic rhinitis and cancer [2; 14; 17; 19; 22]. While these benefits are widely recognized in traditional medicine, their scientific validation remains to be fully established. For instance, studies have demonstrated the antioxidant and anti-inflammatory effects of bee products, yet large-scale clinical trials confirming these therapeutic claims are lacking [2; 19]. Highlighting these gaps could pave the way for more robust empirical research to better understand and substantiate the efficacy of apitherapy.

The concept of apitourism has emerged alongside apitherapy, particularly in countries like Slovenia, where the practice integrates beekeeping activities with tourism and education [4; 30]. Apihouses are potentially a significant part of apitourism, offering individuals the opportunity to relax and rejuvenate by experiencing beehive air and the sounds of buzzing bees [27; 28]. These activities

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not only promote individual well-being but also support local economies and raise awareness about the ecological importance of bees [30].

Typically apitherapy involves the use of an apihouse, a specialized shed designed to provide relaxation and therapeutic benefits through proximity to beehives, without direct interaction with the bees. These structures are carefully designed to ensure a controlled environment where individuals can experience the unique stimuli associated with beehives, such as the soothing buzzing of bees, the natural micro-vibrations they generate, and the aromatic hive air. By creating this indirect yet immersive connection, apihouses aim to harness the potential relaxing properties of bee-related stimuli while ensuring the safety and comfort of users. Typically, an apihouse includes two or three beds adjacent to four beehives, which are accessed by bees through openings located outside the structure [28]. The design ensures that individuals can benefit from the natural stimuli of beehives, such as buzzing sounds, micro-vibrations, and hive air, while remaining protected from direct contact [1; 8].

These houses have been established in several European countries, including Slovenia, Hungary and Türkiye, and are gaining attention for their potential health benefits. Despite their increasing popularity, scientific research on the therapeutic effects of apihouses remains limited, necessitating further studies to validate their impact on human health and well-being [28].

Our hypothesis was that the apihouse environment, particularly the bee buzzing sound, has a relaxing effect that can decrease anxiety levels. To test this, we compared human volunteers exposed to the real apihouse experience with those exposed solely to auditory stimuli, aiming to identify the core elements responsible for the therapeutic effects. Therefore, the primary aim of this study is to evaluate the potential anxiety-reducing benefits of apihouse-specific features, such as hive air and buzzing sounds, and to provide empirical evidence supporting their claimed health benefits [27; 28]. By isolating the key components contributing to relaxation, we seek to advance the understanding of apitherapy practices and help develop apihouses as therapeutic spaces.

MATERIALS AND METHODS

The study was conducted at Ceylan Bee Farm in Karaburun, Izmir, Türkiye. The site includes three apihouses, two of which are identical wooden structures used for the experiments. These apihouses are designed to ensure controlled airflow and safety, promoting a consistent experience for participants. Each apihouse is equipped with four beehives on either side, forming “bee beds” where participants sit (Figure 1). The beehives are constructed with six frames each and the apihouses are designed to ensure safe exposure to bee-related stimuli without direct contact.

The study included 60 participants aged between 18 and 65, randomly divided into two groups of 30 each. The first group, referred to as the “apihouse group,” experienced the apihouse with beehives including bees, while the second group, the “sound group,” listened to recorded sounds of bees buzzing sitting on the beehives not including bees. Both groups were informed that bees were present. Participants were screened for bee allergies, phobias and psychiatric medication use and the ones positive for any of these were not included in the experiment. Informed consent was obtained, ensuring adherence to ethical guidelines.

To examine the effect of bee sounds, recordings were taken within the apihouse using a high-quality portable recorder (Zoom H4n Pro) in May and June 2023. These recordings captured ambient hive sounds just before the experiments and were used for the sound group to simulate the apihouse experience without live bees. The recorded sounds were processed to remove unwanted external noise and analysed by using Audacity [25] and played back to participants through earphones.

The experimental procedure included six stages: filling out the consent form, initial anxiety assessment using the STAI-AD, pre-EEG data recording, the apihouse or sound exposure, post-EEG data recording and a final anxiety assessment (EEG results are going to be reported elsewhere). Each participant spent 10 minutes in the apihouse or listening to the sound recording, and data collection occurred during the early morning to minimize environmental variations and high temperatures.

The STAI-AD was administered in Turkish to assess participants’ anxiety levels before and after both exposures [24]. This widely used inventory evaluates state and trait anxiety [21] and has been validated for its Turkish version

in Türkiye for reliability and accuracy [18]. Moreover, one of the reasons for applying STAI-AD inventory just before the experiment is to minimize the effects of different cognitive and emotional states of participants. The statistical analysis was performed by using SPSS (IBM SPSS Statistics 29.0.1.0).

RESULTS

Analysis of the bee buzzing sound recorded within the apihouse in May and June revealed dominant frequencies ranging from a minimum of 237 Hz to a maximum of 416 Hz (Figure 2), with an average peak frequency calculated at 274 Hz. In total, 30 sounds were recorded but 13 of them were eliminated from the analysis due to the problems such as bad signal quality in the EEG data of the participants. These dominant frequencies were consistently observed and were not significantly affected by weather conditions, indicating the reliability of the auditory exposure.

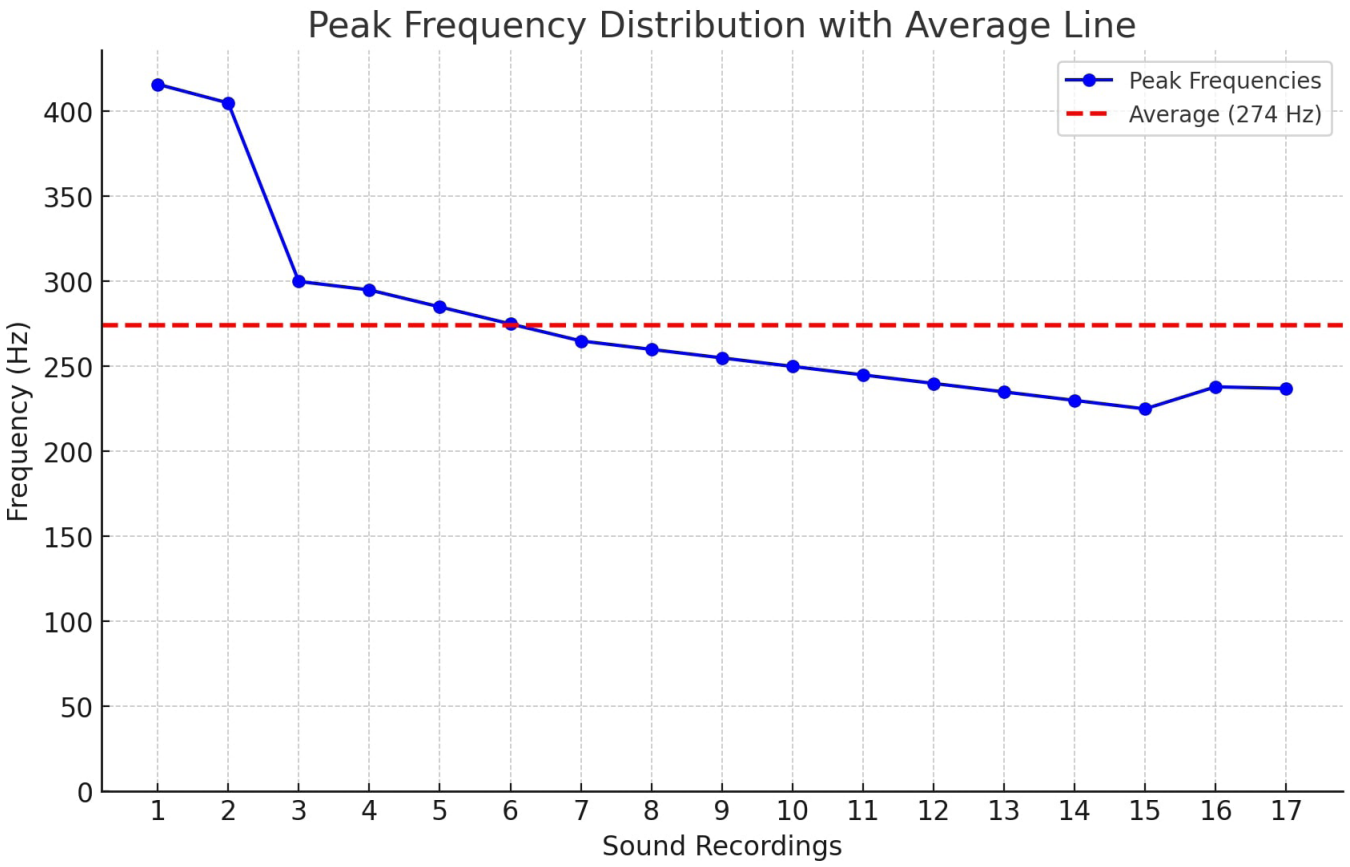

Table 1. The peak frequencies of apihouse sound recording

Participants reported significant decreases in state (n=29) and trait (n=28) anxiety levels after experiencing the real apihouse environment compared to levels before the experience. These preliminary results were statistically significant ($p < 0.001$), supporting the hypothesis that the apihouse environment may effectively reduce anxiety (Table 1). Participants exposed solely to the recorded bee buzzing sound also showed a reduction in both state (n=24) and trait (n=20) anxiety levels (Table 2). These reductions were also statistically significant ($p < 0.001$), indicating that auditory stimuli alone can also provide therapeutic benefits. Some of the participants' anxiety inventory were eliminated due to more than three unanswered questions (11).

Condition	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	One-Sided p	Two-Sided p
State Before-After	5.93103	7.08586	1.31581	3.23527	8.62635	4.508	28	<.001	<.001
Trait Before-After	2.85714	4.78976	0.90518	0.99987	4.71442	3.156	27	.002	.004

Table 2. Paired samples test of the apihouse group

Condition	Mean	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	One-Sided p	Two-Sided p
State Before-After	4.875	4.87507	0.99512	2.81644	6.93356	4.899	23	<.001	<.001
Trait Before-After	3.05	2.37254	0.53052	1.93962	4.16038	5.749	19	<.001	<.001

Table 3. Paired samples test of the sound group

Participants in both groups perceived the duration of the 10-minute exposure as slightly shorter than its actual length. The apihouse group perceived the elapsed time as 9.60 ± 4.57 minutes, while the sound-only group estimated it as 9.35 ± 4.66 minutes, showing no significant difference either between groups or from the actual time of the experience.

DISCUSSION

Both the real apihouse experience and bee buzzing sound exposure were effective in reducing participants' anxiety levels, as evidenced by significant reductions in both state and trait anxiety scores. The apihouse experience appeared to offer more comprehensive benefits, likely due to the multisensory nature of the environment. Elements such as the scent of the hive, the buzzing sound, and the micro-vibrations of bees may have contributed to the calming effect. While the study was unable to pinpoint which specific factor was the most influential, it suggests that the bee buzzing sound is one of the strongest candidates. These findings align with broader literature indicating that natural sounds and environments are effective in reducing stress and anxiety levels [6; 10; 23].

On the other hand, comparison between the apihouse group and the sound exposure group revealed no significant difference in the level of anxiety reduction. This suggests that the bee buzzing sound itself may be a major contributor to the therapeutic effects observed in the real apihouse experience, although variations in sound perception between the groups, likely due to the listening methods used, may have influenced the comparative results. Furthermore, comparisons with other studies indicate that the recorded peak frequencies are within the range of relaxed and normal bee activity [13; 32] and are effective in promoting relaxation, consistent with previous findings on the therapeutic potential of natural sounds [3; 7; 22].

Moreover, participants' time perception was slightly altered by both the apihouse experience and the sound exposure. On average, the perceived duration was slightly shorter than the actual exposure time of 10 minutes, although this difference was not statistically significant. Variations in individual time perception might be attributed to differences in mental states, as previous studies have shown that anxiety or stress can distort time perception [15; 26]. While these findings were not conclusive, they contribute to the understanding of the complex relationship between sensory experiences, relaxation, and cognitive processing of time.

Our study has some limitations. For instance, the cognitive and emotional states of participants before exposure might have varied due to the random selection of visitors, complicating standardization. Administering an anxiety inventory before the experiment might have mitigated some of these variables. Additionally, this study was conducted in a natural environment rather than a controlled laboratory setting, which introduced several challenges, such as external disturbances that occasionally distracted participants and compromised data quality. Importantly, the exposure duration for both groups was limited to 10 minutes, which contrasts with the longer exposure times recommended for real apihouse experiences by the owner of the bee farm. This shorter duration may have been insufficient to observe significant changes, highlighting the need for extended exposure in future research. Finally, while the apihouse group was listening to the bee buzzing sound in the natural environment, the sound group was listening to it with earphones. However, before the experiment, both groups were informed that there are live bees in the beehives to prevent any difference in the results owing to any kind of possible instinctive bee fear. To prevent the listening group realize that there are no bees in the beehives, they walked through a path that they were not able to see the near side of the apihouse because in the normal apihouse bees are flying outside of the beehives.

FURTHER RESEARCH

This study represents a first investigation into the effects of apihouses on anxiety levels, laying the groundwork for further exploration in this area. Future studies should consider implementing a fully randomized control group to isolate and better understand the specific contributions of apihouse elements to observed outcomes. Expanding the sample size and eliminating restrictions such as time constraints or posture limitations could provide further insight into mechanisms involved. Such refinements will also allow for comprehensive sleep studies and more detailed analyses of the effects of apihouses.

Additionally, extended experiments could explore other contributing factors within the apihouse environment, such as the scent of beehives, emitted chemicals, and magnetic or electrical fields. Advanced tools like functional MRI or MEG may provide a deeper understanding of neural mechanisms, especially in brain regions like the amygdala, linked to anxiety regulation. Investigating these aspects will enrich the scientific understanding of apihouse benefits.

In conclusion, this study underscores the potential of the apihouse experience and the buzzing sounds of bees within the apihouse to reduce anxiety levels in humans. While the calming effects of the apihouse environment were supported, the analysis also provided novel insights into the characteristics of the buzzing sound within the apihouse, documenting an average peak frequency of 274 Hz. The therapeutic benefits demonstrated by the apihouse experience lay a foundation for further exploration into the interplay between humans, bees, and their environment, contributing to advancements in apitherapy, ecopsychology, and holistic well-being.

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