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Mud Hive: An Eco-friendly Approach for *Apis mellifera*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The stationary mud hive, designed as a non-transportable alternative to the BIS wooden hives, adheres to the same frame dimensions. A site with direct sunlight is chosen, and the hive is built using a mud mixture, iron planks, and standard Indian bricks (7.5 × 3.54 × 3.54 inches). A brick with a bee entry gate (6 × 2 inches) is made. The entire structure is then layered with mud, providing effective thermal insulation. After drying and sintering for strength, it holds up to 10 BIS frames. This traditional construction approach offers a reliable and environmentally sustainable alternative to modern beekeeping methods.

Keywords: Mud hive; Epic mellifera; weatherproofing; eco-friendly.

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1. INTRODUCTION

The state of Telangana has a geographical area of approximately 112,077 sq km. Telangana State, in general, experiences a tropical climate, is geographically located in a semiarid area and has a predominantly hot and dry climate. The region is divided into three agroclimatic regions on the basis of factors such as temperature, rainfall, and soil type.1 The northern Telangana Zone has temperatures ranging from 15°C-25°C in the winter and 32°C-40°C in the summer. The Central Zone has winter temperatures ranging from 18°C--25°C and summer temperatures ranging from 32°C-38°C. The southern Zone experiences winter temperatures ranging from 20°C--26°C and summer temperatures ranging from 32°C--38°C. The average maximum temperature of Telangana state is 34.2°C, and the minimum temperature is 21.6°C [1]. *Apis mellifera* – Apis, which is Latin for 'bee', and mellifera, which is Latin for 'honey-bearing' – refers to Western or European honeybees. Research shows that regardless of the ambient temperature, the in-hive microclimate of a beehive at the central brood area must be maintained at the average optimum temperature of 32–36°C for the colony to survive [2]. This bee prefers a nesting habitat under closed conditions with low light intensity and usually builds multiple combs in different types of bee hives, *viz*., modern bee hives, under ground, simple wooden boxes, wall crevices, and road culverts [3]. These bees have naturally evolved to thermoregulate their hives, employing several strategies to maintain this optimal temperature. Historically, bees in nature preferred cavities such as caves or hollow trees as nesting sites. Early beekeepers utilized clay pots, wooden logs and skeps as beehives [4]. However, these structures often result in destruction of the hive during honey harvesting. The invention of the movable frame by L.L. Langstroth in the mid-19th century revolutionized beekeeping, allowing for more efficient honey extraction without damaging the hive. However, these hives might not provide insulation for honeybees during summer and winter. Therefore, to survive both cold winters and hot summers, *Apis mellifera* employs several heating and cooling strategies to thermoregulate their hives at the optimum temperature. Another drawback of these hives is that when small-scale farmers use 2 to 3 colonies for pollination in fields, they are often knocked over by wild boars at night. Given the challenges of providing adequate insulation against Telangana's temperature fluctuations and safeguarding hives from threats such as wild boars in the field. A viable solution lies in constructing beehive boxes from a blend of fine red or black soil, bricks, and water. This locally sourced material offers excellent thermal insulation, ensuring a stable hive environment even during the hottest summers and coldest winters. By harnessing the benefits of mud hive construction, beekeepers can ensure the health and productivity of their bee colonies while remaining rooted in sustainable and traditional practices. Previous studies have reported that mud hives were constructed for the native bee species *A. cerana* [5,6,7]. However, there has not been an attempt to use them for *A. mellifera*, even though these bees are known for increased honey production and effective pollination. The mud hive is referred to as a "stationary bee hive" because, unlike the Bureau of Indian Standard (BIS) wooden beehives, it cannot be moved from one location to another. However, the frame dimensions of the mud hive match those of the BIS-type hives. As a result, these frames are transferable and can be relocated between stationary hives or even to BIS wooden hives.

2. STEP-BY-STEP PROCEDURE TO BUILD A TRADITIONAL MUD BEEHIVE: *A. Mellifera*

1. **Site Selection:** Choose a location with direct sunlight. The site was ensured to be free from debris. If the chosen area is not naturally elevated, consider creating a raised platform using a cement slab to facilitate the construction of the mud hive. Positioning the hive entrance facing east is advisable, as it allows morning sunlight to reach the hive early, encouraging the bees to start foraging early in the day.
2. **Layout Preparation:** Position iron planks in the intended hive location or place a Langstroth wooden hive as a reference. The boundaries for the mud hive construction are marked. Ensure that the dimensions adhere to BIS hive standards.
3. **Foundation Preparation:** Excavate the marked area to a depth of 10 cm to establish a sturdy base for the hive.
4. **Mud Mixture:** A mixture of soil and water was prepared to create a thick paste. This will act as a binding material for the bricks

1. Site Selection

2. Layout Preparation

3. Foundation Preparation

4. Mud mixture

5. Iron plank and Frame Placement

6. Brick Arrangement

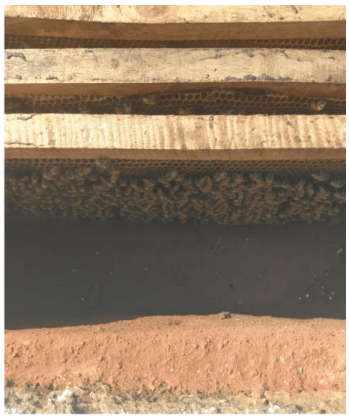
7. Bee Entry

8. Finalizing Structure

9. Drying

10. Burning for Strength

11.Repairs and Cleaning



12.Colony Introduction

Plates. 1-12

5. **Iron Plank and Frame Placement:** Position the iron planks and ensure that the frame fits correctly within the brood area. The inner four walls of the block are the same as those of a BIS brood chamber. The internal depth should measure 9 inches, and the width should be 18.5 inches for placing the frames. The width of the space should be approximately 15 inches. For those intending to construct a mud hive for *Apis cerana*, it is feasible to employ the same method. However, for a more specialized approach, one might refer to Mud hive technology [8].
6. **Brick Arrangement:** Stack bricks using a mud mixture as a mortar between bricks. For this construction, standard Indian bricks (7.5 × 3.54 × 3.54 inches), which are readily available on the market, were used.
7. **Bee Entry:** A brick is chosen, and an entry hole measuring 6 × 2 inches is carved, which serves as an entry gate for incoming and outgoing honey bees. This brick is positioned centrally in the mud hive structure.
8. **Finalizing Structure:** Once the hive structure is complete, a layer of the mud mixture is applied on the external surface for added insulation and protection.
9. **Drying**: The constructed hive was allowed to dry completely for 3--4 days depending on the weather conditions.
10. **Burning for Strength:** Fill the hive's interior and exterior with grass and ignite it. This sintering process strengthens the hive, causing particles to bind firmly together and rendering the hive resistant to rain.
11. **REPAIRS and Cleaning:** After burning, cracks might be observed on the hive exterior. These cracks were patched on the outer walls and inner walls with mud paste to provide a better finish to the outer and inner surfaces of the newly prepared mud hive. Ensuring that the hive's interior is cleared of charred debris.
12. **Colony Introduction:** Transfer the bee colony to the newly constructed mud hive. This hive can accommodate up to 10 BIS frames.

3. MANAGEMENT GUIDELINES FOR FIXED MUD HIVES

- **Sunlight Exposure:** These hives are placed in areas with ample sunlight. Shaded regions might hinder their performance. It is vital to ensure that they receive sunlight for as long a duration as possible daily.
- **Maintence with Cow Dung Paste:** For optimal hive performance, both the inner and outer walls should be plastered with cow dung paste at least biannually or as necessary. This not only strengthens the

structure but also deters pests such as ants, wax moths, and other potential threats.

- **Weatherproofing:** The top covers of the hives need to be well constructed to prevent rainwater intrusion. Excess moisture can adversely affect hive health, endangering hive longevity and productivity**.**

Advantages:

- **Temperature Regulation:** Fixed mud hives excel in temperature regulation. In winter, they record temperatures 2–3°C higher, and in summer, they remain 6–8°C cooler Than wooden ISI hives [6].
- **Cost-Effective:** These hives are not only effective but also cost-efficient. They are approximately half the price of wooden hives. Moreover, most construction materials are easily available and are often free of cost for farmers.
- **Eco-Friendly Construction:** Traditional hives make use of locally sourced materials. Some even utilize wall spaces within homes, offering protection against wild animals and creating a conducive temperature environment [9].

Scientific Management Opportunity: Despite their traditional roots, these hives provide a platform for the scientific management of honey bee colonies [10].

Disadvantages:

- The major limitation of these particular hives is their unsuitability for migratory beekeeping. However, this imitation can be addressed by shifting the frames to a transportable hive

4. CONCLUSION

The stationary mud hive made from low-cost locally available materials like mud, bricks, and some iron planks is an indigenous innovative, sustainable alternative to the wooden hives of *Apis mellifera*. Mud acts as a thermal natural insulator, so it helps to balance the temperature in the hive which gives better protection from extreme weather conditions. In addition, mud hives are low in cost, environmental friendly, and repellent to pests such as Ants and Wax Moths if cow dung paste is used in their maintenance. However, they are static and aren't meant for migratory beekeeping, the transferability of frames to BIS hives compensates for this limitation. So, this concept illustrates how the traditional practices succeed in harmony with modern apicultural practices and support ecologically sustainable hive life and effective colony management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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