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Evaluating the efficacy of herbal agarbattis in the biocontrol of houseflies (*Musca domestica L.):* A sustainable alternative for eco-friendly pest management

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Abstract
The present study examines the effectiveness of herbal agarbattis (incense sticks) made with essential oils, Neem (*Azadirachta indica*), Lavender (*Lavandula angustifolia*), Lemongrass (*Cymbopogon citratus*), and Clove (*Syzygium aromaticum*), as a natural method for controlling houseflies (*Musca domestica L.*). Addressing the increasing resistance of houseflies to chemical insecticides and the environmental and health concerns linked to them, this research aims to find eco-friendly, sustainable alternatives. The project involved preparing herbal incense formulations, followed by laboratory, cage, and field testing, including public surveys in Morigaon Town, Assam. Evaluation focused on repellent efficacy, user satisfaction, and comparison with commercial repellents. The results showed that the herbal agarbattis displayed promising repellent effects, significantly lowering housefly activity, with high public approval and no reported adverse effects. The study endorses the potential of herbal formulations in integrated pest management strategies, providing an affordable and environmentally safe solution for housefly control.

Keywords: Herbal agarbatti, *Musca domestica*, natural repellent, housefly management, integrated pest management (IPM)

Introduction
Houseflies (*Musca domestica L.*) are among the most common synanthropic pests, responsible for transmitting over 100 pathogens, including bacteria, protozoa, and helminths. These insects act as mechanical vectors of diseases such as cholera, typhoid, dysentery, and diarrhoea, posing significant public health concerns worldwide. Historical records have consistently documented their role in disease outbreaks, ranging from dysentery epidemics during wartime to modern-day cases of Salmonella and E. coli transmission. Conventional control methods have relied heavily on chemical insecticides, such as organophosphates, carbamates, and pyrethroids. However, the indiscriminate use of such chemicals has resulted in insecticide resistance, ecological imbalance, and adverse health impacts. In light of these challenges, there has been growing interest in eco-friendly alternatives such as essential oils and herbal formulations. Neem, clove, lemongrass, and lavender oils have shown proven repellent, larvicidal, and antimicrobial properties in prior studies. This research was conducted to evaluate the efficacy of incense sticks infused with these essential oils as a sustainable and culturally acceptable tool for integrated pest management.

Materials and Methods
Study Organism
The common housefly (*Musca domestica L.*), a cosmopolitan species, was chosen for this study due to its rapid reproduction and role in spreading pathogens. Females can lay up to 500 eggs in decaying organic matter, leading to rapid population growth in unsanitary environments.

Preparation of Herbal Incense
Herbal incense sticks were prepared using sawdust (30%), charcoal powder (20%), joss powder (40%), and neem leaf powder (10%). The mixture was kneaded with water and a small quantity of ghee to form a pliable dough, rolled onto bamboo sticks, and shade- dried for 24–48 hours. After drying, the sticks were infused with essential oils of neem, clove, lemongrass, and lavender. Finally, the sticks were re-dried and stored in airtight, eco-friendly packaging.

Experimental Setup
Houseflies were collected from Morigaon, Assam, and reared under controlled conditions. Laboratory caged experiments were conducted to evaluate repellency, with observations recorded at intervals. Field trials were also conducted in five households and two chicken shops in Morigaon. User surveys were conducted to collect data on perception, safety, and effectiveness.

Photoplate 1: Shade dried neem leaves (Azadirachta indica)

Photoplate 2: Powdered form of neem leaves, sawdust and charcoal powder along with cowghee

Photoplate 3: Seived the above mentioned ingredients

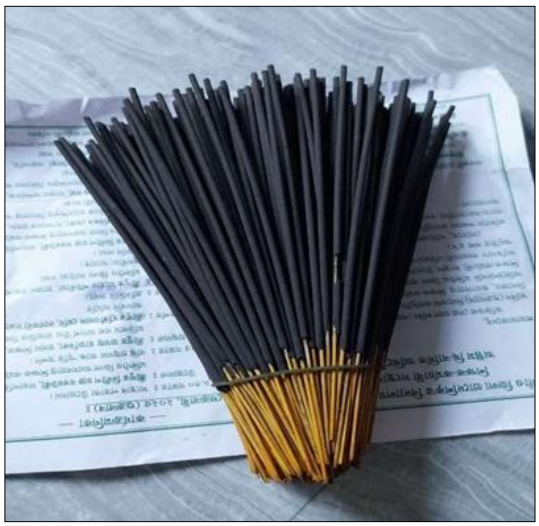
Photoplate 4: Fine powder obtained after seiving

Photoplate 5: Essential oil for fragrance and repellency effect

Photoplate 6: Conical agarbatti formation

Photoplate 7: Shaping of the mixture into agarbatti

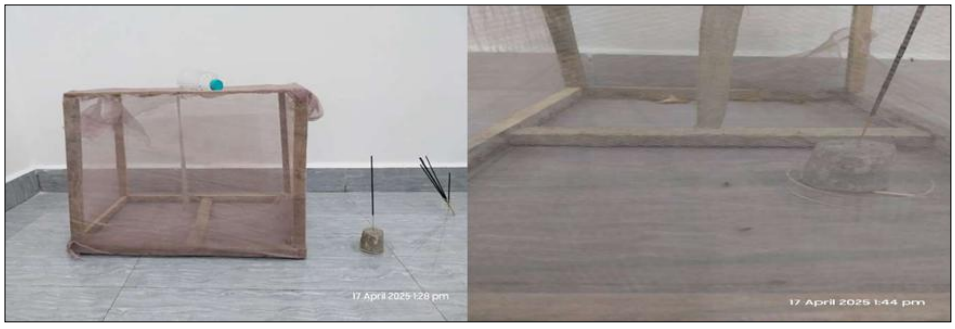
Photoplate 8: Sun drying of the final product



Results

- **Laboratory Evaluation**

Repellency tests demonstrated that the herbal agarbattis were effective in reducing housefly activity. Within 15 minutes of burning, repellency reached approximately 50%, and by 75 minutes, levels increased to 80–90%. The sticks exhibited an average burn time of 70–85 minutes, producing minimal ash and emitting a pleasant aroma.



- **Field Trials**

Households and chicken shops reported a visible decline in housefly populations within 20 minutes of exposure to incense smoke. Cumulative effects were observed, with day-wise reductions ranging from 45–55% on day 1 to 70–80% on day 3.

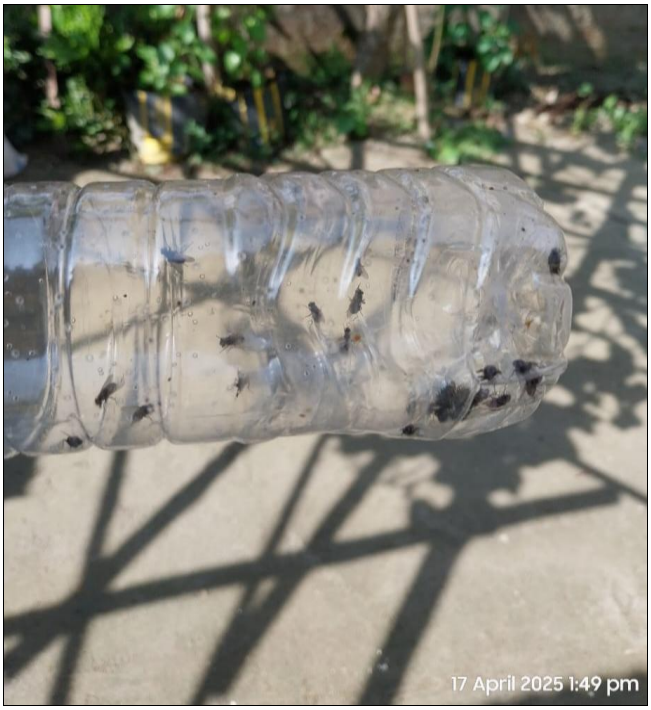
- **User Feedback**

Most participants rated the aroma positively, especially lavender and lemongrass. The product was perceived as easy to use and safe. No significant adverse effects were reported, except for one case of mild eye irritation in a poorly ventilated area.

Discussion

The results confirm the efficacy of herbal agarbattis as an eco-friendly alternative to chemical repellents. Compared to conventional insecticides, the sticks provided comparable repellency without causing resistance, environmental pollution, or health hazards. The dual role of these incense sticks as both repellents and room fresheners enhances their cultural acceptance and practicality. The observed

cumulative effect suggests that essential oils retain residual action, offering extended protection against houseflies. These findings align with previous studies on neem, clove, and lemongrass oils as natural insect repellents. However, limitations such as small sample size, short trial duration, and geographical restriction highlight the need for further large-scale studies.



Conclusion

This study demonstrated that herbal agarbattis infused with essential oils of Neem, Lavender, Lemongrass, and Clove are effective in reducing housefly populations by 65– 80%. They are safe, affordable, eco-friendly, and culturally acceptable. Unlike chemical sprays, these incense sticks pose minimal risk to human health and the environment. With further refinement and large-scale validation, herbal agarbattis can play a significant role in sustainable pest management strategies.

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