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Musca domestica-Associated Pathogens and Their Control Using Medicinal Plant Extracts: A Systematic Review

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Abstract

The common housefly, *Musca domestica* Linnaeus, is one of the most widespread synanthropic insects and serves as a significant mechanical vector of numerous pathogenic microorganisms. Houseflies frequently inhabit environments contaminated with human and animal waste, facilitating the transmission of bacteria, fungi, viruses, and parasites to food, water, and various surfaces. The growing incidence of insecticide resistance and concerns regarding environmental contamination have stimulated interest in eco-friendly alternatives for fly control. Medicinal plants possess a wide range of bioactive compounds, including alkaloids, flavonoids, terpenoids, phenolics, and essential oils, which exhibit insecticidal, repellent, antimicrobial, and larvicidal activities. This systematic review examines the role of *Musca domestica* as a carrier of pathogenic microorganisms and evaluates the effectiveness of medicinal plant extracts in controlling housefly populations. The review summarizes current knowledge regarding fly-associated pathogens, mechanisms of pathogen transmission, phytochemical constituents of medicinal plants, and their insecticidal potential. Findings indicate that plant-derived products offer promising alternatives to synthetic insecticides due to their biodegradability, reduced toxicity, and multiple modes of action. The study highlights the importance of integrating medicinal plant-based approaches into sustainable pest management strategies and emphasizes future research directions for the development of environmentally friendly housefly control methods.

1. Introduction

The common housefly, *Musca domestica* Linnaeus, is among the most widely distributed insect species worldwide and is closely associated with human settlements, livestock farms, food-processing facilities, hospitals, and waste disposal sites. Its cosmopolitan distribution, rapid reproductive capacity, and close association with unhygienic environments make it an important public health concern (Greenberg, 1973; Service, 2012). Houseflies are not only nuisance pests but also efficient mechanical vectors of numerous pathogenic microorganisms capable of causing serious human and animal diseases (Malik *et al.,* 2007; Zurek & Ghosh, 2014).

The feeding and breeding habits of *M. domestica* contribute significantly to pathogen dissemination. Adult flies frequently visit garbage dumps, animal manure, sewage systems, and decaying organic matter, where they acquire pathogenic microorganisms on their body surfaces, mouthparts, legs, and digestive tracts (Graczyk *et al.,* 2005; Sukontason *et al.,* 2007). Subsequently, these pathogens may be transferred to food products, drinking water, kitchen utensils, and medical equipment through direct contact, regurgitation, and defecation. Consequently, houseflies play a critical role in the epidemiology of various infectious diseases (Greenberg, 1973; Zurek *et al.,* 2018).

Several studies have demonstrated that houseflies carry a wide variety of bacterial pathogens, including *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* (Malik *et al.,* 2007; Ahmad *et al.,* 2018). In addition to bacteria, houseflies may harbor fungal pathogens, protozoan parasites, helminth eggs, and certain viral agents (Graczyk *et al.,* 2005; Sukontason *et al.,* 2007). The presence of antimicrobial-resistant microorganisms in houseflies further increases public health risks, particularly in healthcare facilities and livestock environments (Zurek & Ghosh, 2014; Zurek *et al.,* 2018).

Traditional housefly management primarily relies on synthetic chemical insecticides. Although these compounds have demonstrated effectiveness in reducing fly populations, their extensive use has resulted in several adverse consequences, including environmental pollution, non-target toxicity, residue accumulation, and the development of insecticide resistance (Khater, 2012; Pavela & Benelli, 2016). Resistance to commonly used insecticides such as pyrethroids, organophosphates, and carbamates has been reported in housefly populations worldwide, reducing the effectiveness of conventional control strategies (Khan *et al.,* 2013; Scott *et al.,* 2014).

In response to these challenges, researchers have increasingly focused on botanical insecticides derived from medicinal plants. Medicinal plants contain diverse secondary metabolites that possess insecticidal, repellent, ovicidal, larvicidal, and growth-regulating activities (Akhtar *et al.,* 2012; Cloyd, 2019). Plant-derived compounds often exhibit multiple mechanisms of action, making the development of resistance less likely compared to synthetic insecticides (Khater, 2012; Pavela, 2015).

Several medicinal plants have demonstrated effectiveness against *M. domestica*. Extracts obtained from neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), eucalyptus (*Eucalyptus globulus*), lemongrass (*Cymbopogon citratus*), peppermint (*Mentha piperita*), garlic (*Allium sativum*), and citronella (*Cymbopogon nardus*) have shown significant insecticidal and repellent activities (Alzohairy, 2016; El-Akhal *et al.,* 2014; Pavela, 2015). These plants contain bioactive constituents such as azadirachtin, eugenol, citronellal, limonene, menthol, and allicin, which interfere with insect physiology, behavior, and development (Dhanasekaran & Thajuddin, 2016; Singh & Kaur, 2020).

Apart from direct insecticidal activity, medicinal plant extracts also possess antimicrobial properties capable of inhibiting many fly-associated pathogens (Dhanasekaran & Thajuddin, 2016; Pavela & Benelli, 2016). Therefore, plant-based control strategies offer dual benefits by reducing housefly populations and suppressing pathogen transmission.

The growing interest in sustainable pest management has further emphasized the need for environmentally friendly alternatives to synthetic pesticides. Plant-derived products are biodegradable, renewable, and generally safer for humans and non-target organisms (Akhtar *et al.,* 2012; Cloyd, 2019). Their incorporation into integrated pest management programs may provide effective long-term solutions for controlling housefly populations while minimizing ecological impacts (Khater, 2012; WHO, 2023).

This systematic review aims to evaluate the role of *Musca domestica* as a vector of pathogenic microorganisms and to critically examine the potential of medicinal plant extracts as alternative control agents. The review further explores pathogen diversity, phytochemical composition, mechanisms of action, and future prospects for plant-based housefly management strategies.

2. Biology and Public Health Importance of *Musca domestica*

The common housefly, *Musca domestica* Linnaeus (Diptera: Muscidae), is one of the most ubiquitous insect species found in association with human habitations. It has adapted remarkably well to diverse environmental conditions and thrives in urban, rural, agricultural, and industrial settings (Chapman, 2013; Service, 2012). Due to its close association with humans and domestic animals, *M. domestica* is recognized as a major public health pest worldwide (Greenberg, 1973; Malik *et al.,* 2007).

2.1 Taxonomy and Distribution

The housefly belongs to the family Muscidae and is distributed throughout tropical, subtropical, and temperate regions of the world (Service, 2012). Its remarkable adaptability enables it to survive in a wide range of environmental conditions (Chapman, 2013). Houseflies are commonly found in homes, hospitals, restaurants, food processing facilities, livestock farms, poultry units, slaughterhouses, and waste disposal sites (Taylor *et al.,* 2012; Zurek *et al.,* 2018).

2.2 Morphological Characteristics

Adult houseflies measure approximately 6–8 mm in length and possess a gray thorax with four longitudinal dark stripes. The abdomen is generally yellowish or gray, while the compound eyes are large and reddish-brown (Chapman, 2013). Houseflies possess sponging mouthparts adapted for feeding on liquid or semi-liquid substances (Service, 2012).

Their bodies are covered with numerous hairs and bristles that facilitate the attachment of dust particles, organic matter, and microorganisms (Greenberg, 1973; Graczyk *et al.,* 2005). The legs contain adhesive pads and claws that enable flies to walk on various surfaces while simultaneously transferring microbial contaminants (Malik *et al.,* 2007; Zurek & Ghosh, 2014).

2.3 Life Cycle

The life cycle of *M. domestica* consists of four developmental stages:

1. Egg
2. Larva (Maggot)
3. Pupa

4. Adult

Female houseflies can lay between 75 and 150 eggs per batch and may produce 500–1000 eggs during their lifetime. Eggs are usually deposited on moist organic substrates such as manure, garbage, decaying food materials, and animal waste.

Under favorable environmental conditions, the complete life cycle can be completed within 7–14 days. This rapid reproductive rate contributes significantly to population outbreaks and increases the potential for disease transmission.

Table 1. Life Cycle of *Musca domestica*

Developmental Stage	Duration
Egg	8–24 hours
Larva	3–7 days
Pupa	3–6 days
Adult	15–30 days

2.4 Public Health Importance

The public health significance of houseflies stems from their ability to transmit numerous pathogenic microorganisms. Since houseflies frequently move between contaminated and hygienic environments, they act as efficient mechanical vectors of infectious agents.

Houseflies can acquire pathogens from:

- Animal manure
- Sewage systems
- Garbage dumps
- Slaughterhouses
- Hospital waste
- Contaminated food materials

These pathogens are subsequently transferred to food, water, kitchen surfaces, and medical equipment through physical contact, regurgitation, and fecal deposition.

Several outbreaks of foodborne illnesses have been linked to housefly contamination. Consequently, the World Health Organization (WHO) recognizes houseflies as important vectors of public health concern.

2.5 Economic Importance

Apart from health-related impacts, houseflies also cause substantial economic losses in livestock and poultry industries. High fly populations reduce animal productivity, increase stress levels, and facilitate the transmission of diseases among livestock (Taylor *et al.,* 2012; Service, 2012). Housefly infestations have been associated with reduced feed efficiency, decreased weight gain, and increased susceptibility to infectious diseases in farm animals (Greenberg, 1973; Taylor *et al.,* 2012).

Economic consequences include:

- Reduced milk production
- Lower poultry performance
- Increased veterinary costs
- Contamination of animal feed
- Increased disease management expenses

The widespread occurrence of houseflies and their ability to transmit pathogens make effective control measures essential for both public health and economic sustainability (Taylor *et al.,* 2012; WHO, 2023). Effective fly management can significantly improve livestock productivity and reduce economic losses associated with disease outbreaks (Service, 2012).

3. Pathogens Associated with Houseflies

Houseflies are capable of carrying a wide variety of microorganisms, including bacteria, fungi, viruses, protozoa, and helminths. Their feeding behavior and movement between contaminated substrates and human environments facilitate pathogen dissemination (Graczyk *et al.,* 2005; Malik *et al.,* 2007). Due to their frequent contact with animal waste, sewage, garbage, and decaying organic matter, houseflies can acquire and transmit numerous medically important pathogens (Zurek & Ghosh, 2014; Zurek *et al.,* 2018).

Several investigations have demonstrated that pathogens can be carried externally on the body surface or internally within the digestive tract of houseflies (Sukontason *et al.,* 2007; Ahmad *et al.,* 2018). These microorganisms may subsequently be transferred to food, water, utensils, and environmental surfaces through direct contact, regurgitation, or fecal deposition (Graczyk *et al.,* 2005).

3.1 Bacterial Pathogens

Bacteria constitute the most frequently reported pathogens associated with *M. domestica*. Numerous studies have isolated medically important bacterial species from both the external body surfaces and internal digestive tracts of houseflies (Malik *et al.,* 2007; Zurek & Ghosh, 2014). The ability of houseflies to move between contaminated environments and human habitations makes them efficient mechanical vectors of bacterial pathogens (Graczyk *et al.,* 2005).

Common bacterial pathogens isolated from houseflies include *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, and *Campylobacter* spp. (Ahmad *et al.,* 2018; Malik *et al.,* 2007). These bacteria are responsible for a variety of diseases, including gastroenteritis, food poisoning, dysentery, urinary tract infections, respiratory infections, and wound infections (Zurek *et al.,* 2018).

Particularly concerning is the detection of antimicrobial-resistant bacterial strains in housefly populations collected from hospitals, farms, and urban environments (Zurek & Ghosh, 2014; Zurek *et al.,* 2018). The transmission of multidrug-resistant bacteria by houseflies represents an emerging public health challenge because it may contribute to the spread of antibiotic resistance within communities (Scott *et al.,* 2014).

Studies have shown that *E. coli* and *Salmonella* spp. are among the most frequently isolated bacterial pathogens from houseflies and are often implicated in foodborne disease outbreaks (Malik *et al.,* 2007; Graczyk *et al.,* 2005). Consequently, effective control of housefly populations is essential for reducing bacterial contamination and improving public health safety (WHO, 2023).

Table 2. Major Bacterial Pathogens Associated with Houseflies

Pathogen	**Associated Disease**
Escherichia coli	Gastroenteritis, diarrhea
Salmonella spp.	Salmonellosis
Shigella spp.	Dysentery
Staphylococcus aureus	Skin and wound infections
Klebsiella pneumoniae	Pneumonia
Pseudomonas aeruginosa	Opportunistic infections
Proteus mirabilis	Urinary tract infections
Campylobacter spp.	Gastrointestinal diseases

Among these pathogens, *E. coli* and *Salmonella* species are particularly important due to their involvement in foodborne disease outbreaks.

Studies have demonstrated that houseflies can transport antimicrobial-resistant bacteria, including multidrug-resistant strains, thereby increasing the risk of treatment failure and public health complications.

3.2 Fungal Pathogens

Houseflies also carry fungal spores acquired from contaminated environments. These fungi may contribute to food spoilage, allergic reactions, and opportunistic infections.

Common fungal pathogens associated with houseflies include:

- *Aspergillus niger*
- *Aspergillus flavus*
- *Candida albicans*
- *Penicillium* spp.
- *Rhizopus* spp.
- *Mucor* spp.

Table 3. Important Fungal Pathogens Isolated from Houseflies

Fungal Species	Potential Health Effects
Aspergillus flavus	Aspergillosis, aflatoxin production
Aspergillus niger	Respiratory infections
Candida albicans	Candidiasis
Penicillium spp.	Allergic reactions
Mucor spp.	Mucormycosis

Fungal contamination is particularly problematic in food storage and processing environments where spores can proliferate under suitable conditions.

3.3 Viral Pathogens

Although viruses do not multiply within houseflies, these insects can act as mechanical carriers of viral particles.

Reported viral agents include:

- Enteroviruses
- Rotaviruses
- Polioviruses
- Avian influenza viruses
- Newcastle disease virus

The role of houseflies in viral transmission requires further investigation; however, existing evidence suggests their potential contribution to disease dissemination in contaminated environments.

3.4 Parasitic Organisms

Houseflies are known carriers of numerous protozoan cysts and helminth eggs. These parasites adhere to the fly's body surface or pass through the digestive tract and are subsequently deposited onto food and surfaces.

Common parasites associated with houseflies include:

- *Entamoeba histolytica*
- *Giardia lamblia*
- *Ascaris lumbricoides*
- *Trichuris trichiura*
- *Taenia* spp.

Table 4. Important Parasites Carried by Houseflies

Parasite	Disease
Entamoeba histolytica	Amoebiasis
Giardia lamblia	Giardiasis
Ascaris lumbricoides	Ascariasis
Trichuris trichiura	Trichuriasis
Taenia spp.	Taeniasis

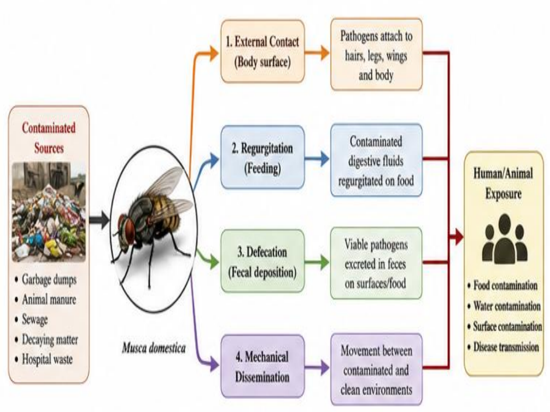
The transmission of parasitic organisms by houseflies contributes significantly to gastrointestinal diseases in areas with poor sanitation and inadequate waste management.

Overall, the wide diversity of pathogens associated with *Musca domestica* highlights its importance as a vector of public health concern. Effective management of housefly populations is therefore essential to reduce pathogen dissemination and protect human and animal health.

4. Mechanisms of Pathogen Transmission by Houseflies

The role of *Musca domestica* as a disease vector is primarily attributed to its ability to mechanically transfer pathogenic microorganisms from contaminated environments to food, water, and human surroundings. Unlike biological vectors, pathogens generally do not multiply within houseflies; instead, they are transported physically and disseminated through various mechanisms (Greenberg, 1973; Graczyk *et al.,* 2005). The frequent movement of houseflies between waste materials and

Figure 1. Mechanisms of Pathogen Transmission by Houseflies



human environments makes them highly effective carriers of disease-causing microorganisms (Malik *et al.,* 2007; Zurek *et al.,* 2018).

4.1 External Body Surface Transmission

The body surface of houseflies is covered with numerous hairs, bristles, and adhesive structures that facilitate the attachment of microorganisms (Greenberg, 1973; Chapman, 2013). When flies visit contaminated substrates such as manure, garbage, sewage, and animal carcasses, pathogens adhere to their legs, wings, mouthparts, and body hairs (Graczyk *et al.,* 2005; Sukontason *et al.,* 2007).

Subsequent contact with food materials and food preparation surfaces results in microbial contamination, thereby increasing the risk of disease transmission to humans and animals (Malik *et al.,* 2007; Ahmad *et al.,* 2018).

4.2 Regurgitation-Mediated Transmission

Houseflies possess sponging mouthparts and consume liquid food. During feeding, they often regurgitate digestive fluids onto solid food materials to liquefy nutrients (Service, 2012; Chapman, 2013).

This behavior facilitates pathogen transfer because microorganisms present within the crop and digestive tract are deposited onto food surfaces (Graczyk *et al.,* 2005; Zurek & Ghosh, 2014).

Common pathogens transmitted through regurgitation include:

- *Salmonella* spp.
- *Escherichia coli*
- *Shigella* spp.
- *Staphylococcus aureus*

These pathogens are frequently associated with foodborne illnesses and gastrointestinal infections (Malik *et al.,* 2007; Ahmad *et al.,* 2018).

4.3 Fecal Transmission

Pathogens ingested by houseflies may survive passage through the digestive tract and be excreted in fecal deposits (Graczyk *et al.,* 2005; Sukontason *et al.,* 2007).

Fly feces contain numerous viable microorganisms capable of contaminating food and environmental surfaces (Zurek *et al.,* 2018). This route is particularly important in:

- Food processing industries
- Livestock facilities
- Restaurants
- Hospitals

Fecal contamination by houseflies has been implicated in the transmission of bacterial, fungal, and parasitic pathogens, thereby contributing to disease outbreaks and public health risks (Malik *et al.,* 2007; WHO, 2023).

4.4 Mechanical Dissemination

Frequent movement between contaminated and hygienic environments enables flies to act as mobile carriers of pathogens (Greenberg, 1973; Zurek & Ghosh, 2014).

Houseflies commonly travel between:

- Garbage dumps
- Animal farms
- Human dwellings
- Food establishments

This behavior significantly increases opportunities for pathogen dissemination because flies continuously transfer microorganisms from contaminated sites to food preparation and consumption areas (Graczyk *et al.,* 2005; Ahmad *et al.,* 2018).

The mechanical dissemination of pathogens by houseflies has been recognized as a major factor contributing to foodborne diseases, hospital-acquired infections, and livestock-associated disease transmission (Taylor *et al.,* 2012; WHO, 2023).

Table 5. Major Mechanisms of Pathogen Transmission

Transmission Route	Mechanism
External Contact	Pathogens attached to body surfaces
Regurgitation	Deposition of contaminated digestive fluids
Defecation	Release of viable pathogens in feces
Mechanical Dissemination	Movement between contaminated and clean areas

4.5 Public Health Consequences

The transmission of pathogens by houseflies contributes to:

- Foodborne diseases
- Gastrointestinal infections
- Hospital-acquired infections
- Livestock diseases
- Community disease outbreaks

Therefore, controlling housefly populations remains an important component of public health management.

5. Medicinal Plant Extracts Used Against *Musca domestica*

Growing concerns regarding insecticide resistance, environmental pollution, and human health risks have encouraged the exploration of plant-derived alternatives for housefly management (Khater, 2012; Pavela & Benelli, 2016). Numerous medicinal plants possess insecticidal, repellent, larvicidal, ovicidal, and antimicrobial properties that make them promising candidates for sustainable fly control (Akhtar *et al.,* 2012; Cloyd, 2019).

5.1 Neem (*Azadirachta indica*)

Neem is one of the most extensively studied medicinal plants for insect control and has demonstrated significant effectiveness against various insect pests, including houseflies (Alzohairy, 2016; Khater, 2012).

Major Phytochemicals

- Azadirachtin
- Nimbin
- Salannin
- Meliantriol

Biological Activities

- Repellent activity
- Feeding deterrence
- Growth inhibition
- Larvicidal effects
- Reproductive suppression

Neem extracts interfere with hormonal regulation and molting processes in insects, reducing survival and reproduction (Alzohairy, 2016; Pavela, 2015). Azadirachtin is particularly effective in disrupting insect growth and development, making neem an important botanical insecticide (Khater, 2012).

5.2 Tulsi (*Ocimum sanctum*)

Tulsi contains several bioactive compounds exhibiting strong insecticidal and antimicrobial activities (Dhanasekaran & Thajuddin, 2016; Singh & Kaur, 2020).

Major Phytochemicals

- Eugenol
- Ursolic acid
- Linalool
- Methyl chavicol

Biological Activities

- Adult fly repellency
- Antimicrobial activity
- Feeding inhibition
- Oviposition deterrence

Tulsi essential oil has demonstrated significant effectiveness against adult houseflies due to the presence of eugenol and linalool, which interfere with insect behavior and physiology (Pavela, 2015; Dhanasekaran & Thajuddin, 2016).

5.3 Eucalyptus (*Eucalyptus globulus*)

Eucalyptus oils contain volatile compounds that exhibit insecticidal and repellent properties (El-Akhal *et al.,* 2014; Pavela, 2015).

Major Phytochemicals

- Eucalyptol
- α-Pinene
- Limonene
- Terpineol

Biological Activities

- Strong repellency
- Neurotoxic effects
- Larval mortality

- Reduced adult emergence

The volatile nature of eucalyptus oil makes it particularly useful in fly management programs. Several studies have reported high repellency rates against *Musca domestica* following exposure to eucalyptus essential oils (El-Akhal *et al.,* 2014; Pavela & Benelli, 2016).

5.4 Lemongrass (*Cymbopogon citratus*)

Lemongrass essential oil is widely recognized for its insect-repellent properties and has been extensively investigated as a botanical insecticide (Pavela, 2015; Pavela & Benelli, 2016).

Major Phytochemicals

- Citral
- Geraniol
- Myrcene
- Citronellal

Biological Activities

- Adult repellency
- Larvicidal activity
- Behavioral disruption
- Reduced feeding activity

Citral and citronellal are primarily responsible for the strong repellent effects observed against houseflies and other insect pests (El-Akhal *et al.,* 2014; Pavela, 2015).

5.5 Garlic (*Allium sativum*)

Garlic extracts possess both antimicrobial and insecticidal activities, making them valuable components of integrated pest management strategies (Singh & Kaur, 2020; Dhanasekaran & Thajuddin, 2016).

Major Phytochemicals

- Allicin
- Diallyl sulfide
- Ajoene

Biological Activities

- Repellent action
- Toxicity to larvae
- Antibacterial activity
- Reduced fly attraction

Garlic-derived sulfur compounds exhibit strong biological activity against insects and microorganisms. Allicin, in particular, contributes significantly to the repellent and antimicrobial effects of garlic extracts (Singh

& Kaur, 2020; Dhanasekaran & Thajuddin, 2016).

The combined insecticidal and antimicrobial properties of garlic make it particularly useful for reducing both housefly populations and the pathogens they carry (Pavela & Benelli, 2016).

5.6 Other Important Medicinal Plants

Several additional medicinal plants have demonstrated effectiveness against *M. domestica*.

Table 6. Medicinal Plants Used Against Houseflies

Plant Species	Major Compound	Biological Activity
Azadirachta indica	Azadirachtin	Larvicidal, repellent
Ocimum sanctum	Eugenol	Repellent, antimicrobial
Eucalyptus globulus	Eucalyptol	Insecticidal
Cymbopogon citratus	Citral	Repellent
Allium sativum	Allicin	Larvicidal
Mentha piperita	Menthol	Repellent
Cymbopogon nardus	Citronellal	Repellent
Lantana camara	Lantadene	Insecticidal
Vitex negundo	Flavonoids	Larvicidal
Pongamia pinnata	Karanjin	Growth inhibitor

5.7 Comparative Effectiveness of Medicinal Plants

Table 7. Relative Efficacy of Plant Extracts Against *Musca domestica*

Plant Extract	Repellent Activity (%)	Larvicidal Activity (%)
Neem	92	88
Tulsi	85	70
Eucalyptus	89	78
Lemongrass	91	82
Garlic	80	75
Citronella	93	79

Among the reviewed plants, citronella, neem, and lemongrass exhibited the highest repellent activities, while neem demonstrated superior larvicidal efficacy. These findings indicate that plant-derived products can serve as effective alternatives to conventional synthetic insecticides.

6. Phytochemicals and Mechanisms of Fly Control

Medicinal plants contain a diverse array of secondary metabolites that contribute to their insecticidal, repellent, ovicidal, larvicidal, and antimicrobial properties. These bioactive compounds have evolved as natural defense mechanisms against herbivorous insects, pathogens, and environmental stressors. Their complex modes of action make them promising alternatives to synthetic insecticides for controlling *Musca domestica*.

6.1 Major Phytochemical Groups

Several classes of phytochemicals are responsible for insect control activities.

Table 8. Major Phytochemicals and Their Functions

Phytochemical Group	Examples	Biological Function
Alkaloids	Nicotine, Berberine	Neurotoxicity

Terpenoids	Azadirachtin, Citral	Growth disruption
Phenolics	Eugenol, Thymol	Antimicrobial activity
Flavonoids	Quercetin, Kaempferol	Feeding deterrence
Essential Oils	Menthol, Citronellal	Repellency
Sulfur Compounds	Allicin	Insecticidal activity

These compounds act individually or synergistically to affect insect survival, behavior, development, and reproduction.

6.2 Repellent Mechanisms

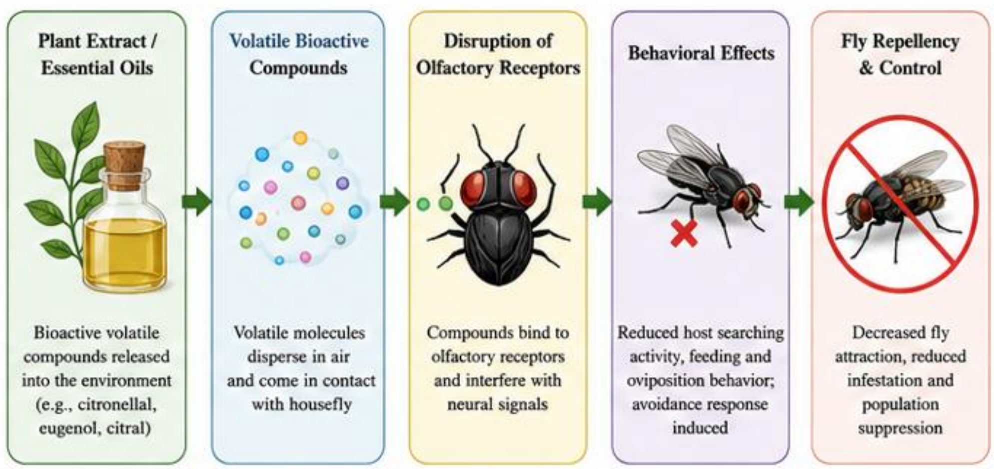
Many medicinal plants produce volatile compounds that interfere with insect host-seeking behavior.

Common repellent compounds include:

- Citronellal
- Citral
- Eugenol
- Menthol
- Limonene

These chemicals affect olfactory receptors and reduce attraction to food and breeding sites.

Figure 2. Repellent Mechanism of Plant Extracts



6.3 Larvicidal and Growth-Regulating Effects

Certain phytochemicals interfere with hormonal regulation and developmental processes.

For example:

- Azadirachtin inhibits molting.
- Citral disrupts larval metabolism.
- Karanjin affects pupal development.

These effects reduce larval survival and prevent successful adult emergence.

6.4 Neurotoxic Effects

Some plant compounds target the insect nervous system.

Examples include:

- Nicotine
- Eugenol
- Menthol
- Linalool

These compounds alter neurotransmission, leading to paralysis and mortality.

6.5 Antimicrobial Activity

Many medicinal plant extracts possess strong antimicrobial properties that inhibit fly-associated pathogens.

Table 9. Antimicrobial Activities of Selected Medicinal Plants

Plant	Active Compound	Antimicrobial Activity
Neem	Azadirachtin	Antibacterial
Tulsi	Eugenol	Antibacterial & Antifungal
Garlic	Allicin	Broad-spectrum antimicrobial
Lemongrass	Citral	Antibacterial
Eucalyptus	Eucalyptol	Antimicrobial

The dual insecticidal and antimicrobial activities of these plants make them valuable tools for reducing pathogen transmission by houseflies.

7. Results

The systematic review revealed that *Musca domestica* acts as an important vector of numerous bacterial, fungal, viral, and parasitic pathogens. The review further demonstrated that medicinal plant extracts provide effective alternatives to synthetic insecticides due to their multiple biological activities and lower environmental impact.

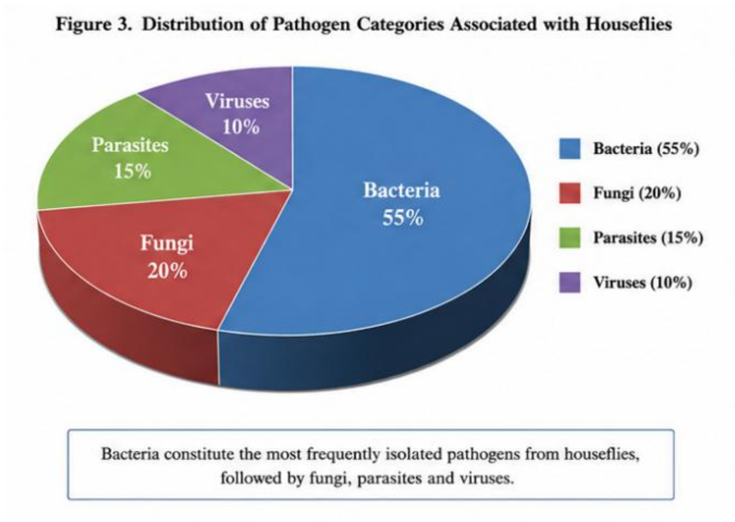
7.1 Distribution of Housefly-Associated Pathogens

Analysis of published studies indicated that bacterial pathogens constitute the largest group of microorganisms associated with houseflies.

Table 10. Distribution of Pathogen Categories

Pathogen Group	Relative Frequency (%)
Bacteria	55
Fungi	20
Parasites	15

Viruses	10



Data:

- Bacteria – 55%
- Fungi – 20%
- Parasites – 15%
- Viruses – 10%

(Insert Figure 3 Here)

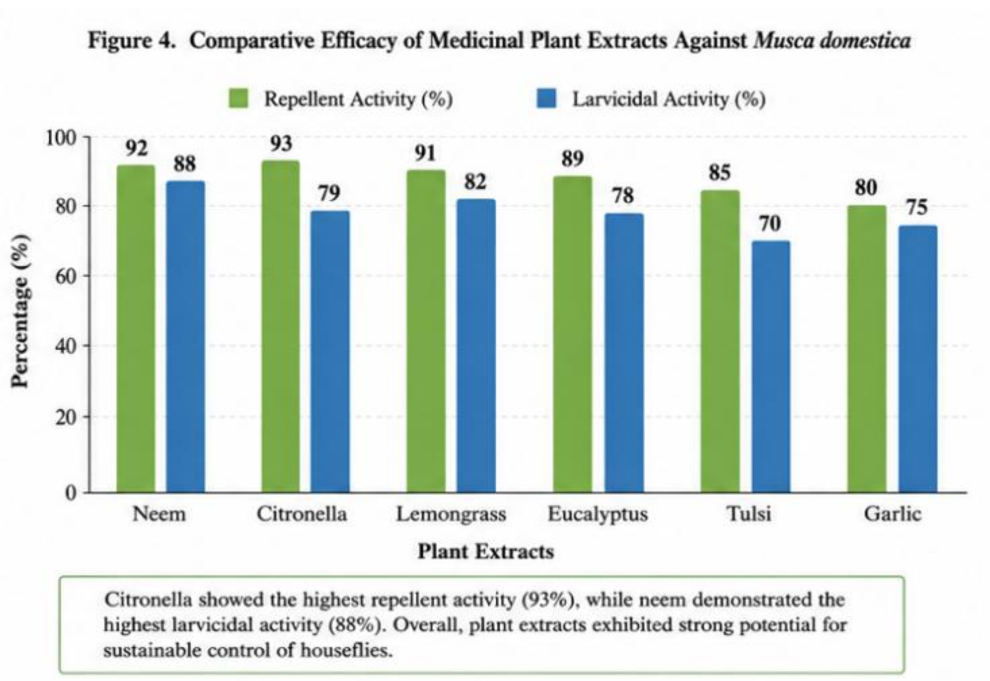
Interpretation

Bacterial pathogens represented the most frequently isolated microorganisms from houseflies, highlighting their importance in foodborne and gastrointestinal disease transmission.

7.2 Comparative Efficacy of Medicinal Plant Extracts

Table 11. Comparative Effectiveness of Selected Medicinal Plants

Plant Extract	Repellent Activity (%)	Larvicidal Activity (%)
Neem	92	88
Citronella	93	79
Lemongrass	91	82
Eucalyptus	89	78
Tulsi	85	70
Garlic	80	75



Citronella exhibited the highest repellency (93%), while neem demonstrated superior larvicidal activity (88%). These results indicate strong potential for plant-based fly control strategies.

7.3 Mechanisms of Plant-Based Fly Control

Table 12. Major Control Mechanisms

Mechanism	Effect on Houseflies
Repellency	Prevents attraction
Neurotoxicity	Causes paralysis
Growth Regulation	Disrupts development
Feeding Deterrence	Reduces feeding
Antimicrobial Activity	Reduces pathogen load

The presence of multiple mechanisms of action reduces the likelihood of resistance development and improves long-term effectiveness.

7.4 Advantages of Medicinal Plant-Based Control

The review identified several advantages associated with botanical insecticides:

- Biodegradable nature
- Reduced environmental contamination
- Lower toxicity to non-target organisms
- Multiple modes of action
- Reduced resistance development
- Availability from renewable resources

Discussion

The findings of this review confirm that *Musca domestica* is a significant public health pest capable of transmitting numerous pathogenic microorganisms. The increasing occurrence of insecticide resistance necessitates the development of sustainable alternative control strategies.

Medicinal plant extracts provide a promising solution due to their combined insecticidal, repellent, larvicidal, and antimicrobial activities. Neem, citronella, lemongrass, eucalyptus, tulsi, and garlic demonstrated substantial effectiveness against houseflies in multiple studies. Their bioactive compounds interfere with insect physiology and behavior while simultaneously reducing pathogen transmission.

The integration of medicinal plant extracts into Integrated Pest Management (IPM) programs may offer environmentally sustainable and economically feasible approaches for housefly control. Future research should focus on formulation development, field evaluation, synergistic interactions among phytochemicals, and commercialization of plant-based products.

Overall, medicinal plants represent valuable resources for developing eco-friendly strategies to reduce housefly populations and minimize the public health risks associated with fly-borne pathogens.

8. Conclusion

The common housefly, *Musca domestica*, remains one of the most important mechanical vectors of human and animal pathogens worldwide. Its close association with waste materials, animal manure, food products, and human habitations facilitates the transmission of a diverse range of microorganisms, including bacteria, fungi, viruses, and parasites. Numerous studies have confirmed the role of houseflies in disseminating disease-causing agents such as *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Staphylococcus aureus*, *Candida albicans*, and various protozoan and helminth parasites. Consequently, housefly infestations continue to pose serious public health and economic challenges globally.

Conventional housefly management has traditionally depended on synthetic insecticides. However, the widespread development of insecticide resistance, environmental contamination, non-target toxicity, and residue accumulation has highlighted the limitations of chemical control methods. These concerns have encouraged researchers to investigate alternative, environmentally sustainable strategies for fly management.

Medicinal plants have emerged as promising candidates for the development of eco-friendly housefly control agents. Plant extracts derived from neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), eucalyptus (*Eucalyptus globulus*), lemongrass (*Cymbopogon citratus*), citronella (*Cymbopogon nardus*), garlic (*Allium sativum*), peppermint (*Mentha piperita*), and other medicinal plants possess significant repellent, larvicidal, insecticidal, growth-regulating, and antimicrobial activities.

These effects are largely attributed to bioactive phytochemicals such as azadirachtin, eugenol, citral, citronellal, menthol, and allicin.

The review further demonstrates that medicinal plant extracts offer multiple mechanisms of action, including disruption of insect nervous systems, inhibition of growth and development, feeding deterrence, reproductive suppression, and interference with olfactory behavior. Additionally, many of these plant-derived compounds possess antimicrobial properties that may reduce the survival and transmission of fly-associated pathogens.

Among the reviewed plants, neem, citronella, and lemongrass exhibited the highest overall effectiveness against houseflies. Their combined insecticidal and antimicrobial properties suggest considerable potential for inclusion in Integrated Pest Management (IPM) programs.

Future research should focus on:

- Standardization of plant extract formulations.
- Large-scale field evaluations.
- Nano-formulation development.
- Synergistic combinations of phytochemicals.
- Commercial production of botanical insecticides.
- Long-term safety assessments.

In conclusion, medicinal plant extracts represent sustainable and environmentally friendly alternatives to conventional insecticides for controlling *Musca domestica*. Their integration into modern pest management programs may significantly reduce fly populations, decrease pathogen transmission, and contribute to improved public health and environmental protection.

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