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Medicinal Plants Effective Against Monkeypox: A Concise Review Focusing on Mechanisms of Action

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A B S T R A C T

Objective: Monkeypox (MPX) is a rare viral disease that has attracted considerable attention in recent years. In the absence of a definitive treatment, medicinal plants have been explored as complementary options for symptom management and immune enhancement. This study aims to investigate medicinal plants in India with potential antiviral effects against MPX, focusing on their active constituents and mechanisms of action.

Methods: Relevant literature was retrieved from reputable scientific databases, including PubMed, Scopus, and Google Scholar, using carefully selected keywords. Studies reporting antiviral activity of medicinal plants against MPX were reviewed and synthesized.

Results: Several medicinal plants with documented effects against MPX were identified. These include *Allium sativum L.*, *Adansonia digitata L.*, *Azadirachta indica A. Juss*, *Boscia senegalensis (Pers.) Lam. ex Pior*, *Carica papaya L.*, *Cissus populnea Guill. & Perr.*, *Cucurbita maxima Duchesne*, *Ficus platyphylla Delile*, *Lawsonia inermis L.*, *Maytenus senegalensis (Lam.) Exell*, *Moringa oleifera Lam.*, *Olea europaea L.*, *Sterculia setigera Delile*, *Acacia nilotica (L.) Delile*, *Anogeissus leiocarpus (DC.) Guill. & Perr.*, *Balanites aegyptiaca (L.) Delile*, *Calotropis procera (Aiton) Dryand*, *Cassia singueana Delile*, *Citrullus lanatus (Thunb.) Matsum. & Nakai*, and *Diospyros mespiliformis Hochst. ex A.DC.*. The active phytochemicals in these plants appear to contribute to viral load reduction and overall health improvement by inhibiting viral entry and attenuating viral activity.

Conclusion: The findings underscore the therapeutic promise of these medicinal plants as complementary interventions for MPX. Their bioactive compounds may offer valuable support in alleviating symptoms and strengthening immune defenses. Continued exploration of such plant-based resources could inform the development of adjunctive strategies for managing viral diseases more broadly.

Keywords: Monkeypox, Virus, Medicinal plants, Remedy

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Introduction

Monkeypox is a zoonotic viral disease caused by the Monkeypox virus, a double-stranded DNA virus belonging to the family Poxviridae and the genus Orthopoxvirus [1]. Genetically, it shares close similarity with other members of the smallpox family, including the Vaccinia virus (used in smallpox vaccines), Variola major and Variola minor (the causative agents of human smallpox), as well as the Cowpox virus [2]. Traditionally, monkeypox has been endemic in the tropical rainforests of Central and West Africa. However, in recent years, increasing cases have also been documented in urban regions and even beyond endemic zones [3].

Following the global surge of infections in recent years, particularly the remarkable rise in cases across European countries, the World Health Organization (WHO) declared monkeypox a “Public Health Emergency of International Concern” (PHEIC) [4]. Transmission typically occurs through direct contact with infected animals or humans. This includes exposure to skin lesions, body fluids, or bites and scratches from infected hosts. Entry into the body occurs via the respiratory tract, broken skin, or mucosal membranes. Human-to-human transmission may also result from close respiratory contact, body fluids, or contaminated objects [5].

Clinically, monkeypox has an incubation period of around 6–13 days (sometimes ranging from 5 to 21 days). Early symptoms include fever, headache, myalgia, chills, fatigue, and lymphadenopathy [6]. This is followed by a characteristic rash resembling smallpox, which progresses through macular, vesicular, ulcerative, and crusting stages. While monkeypox resembles smallpox in presentation, its severity is generally lower. Notably, despite its name, monkeypox bears no relation to chickenpox (Varicella) [7].

The pathophysiology involves initial replication of the virus in regional lymph nodes, followed by viremia, which disseminates the virus to the skin and other organs. This accounts for the fever and characteristic skin lesions. In most cases, the host’s immune response successfully contains the infection. However, severe manifestations can occur, particularly in immunocompromised individuals [8].

In the majority of cases, monkeypox is a self-limiting disease, with symptoms resolving within 2–4 weeks. Current management is largely supportive and symptomatic, focusing on fever reduction, pain control, hydration, and prevention of secondary bacterial infections with antibiotics [9]. Although no definitive antiviral therapy exists, drugs such as Tecovirimat and Brincidofovir originally developed for smallpox have shown promise in severe cases or in high-risk patients [10]. Furthermore, vaccines designed for smallpox prevention, including Jynneos and ACAM2000, have demonstrated protective efficacy against monkeypox and are recommended for individuals at elevated risk [11].

From the perspective of traditional medicine, medicinal plants such as *Thymus vulgaris*, *Crocus sativus*, and *Althaea officinalis* have been used for their anti-inflammatory and immune-boosting properties to alleviate symptoms. These herbs may help reduce fever, promote the healing of skin eruptions, and enhance overall immune resilience. However, their use should always complement, rather than replace, medical care and be supervised by qualified practitioners [12].

Historically, traditional medicine has played a significant role in the prevention and treatment of infectious diseases, including skin infections such as smallpox. Plants like *Glycyrrhiza glabra*, aloe *Aloe vera*, and *Lavandula angustifolia* were widely used to relieve fever, inflammation, and to enhance immune defense. In light of the recent resurgence of monkeypox, exploring the therapeutic potential of medicinal plants as complementary strategies has gained renewed significance [13–15].

Given the global spread of monkeypox and the absence of a definitive cure, raising public awareness of preventive measures and infection-control strategies remains crucial. Limiting direct contact with infectious sources, alongside personal and environmental hygiene, are among the most effective means of curbing transmission. The aim of this review is to identify medicinal plants traditionally used against monkeypox in India and to analyze their active compounds and mechanisms of action. By providing a scientific foundation for their potential application, this study seeks to advance the development of complementary approaches for managing symptoms, enhancing immune defenses, and mitigating the risk of widespread outbreaks.

Methodology

This narrative review was designed to evaluate the antiviral potential of medicinal plants effective against monkeypox and to identify their active compounds and mechanisms of action. The research process followed these steps: authoritative databases including PubMed, Scopus, Web of Science, and Google Scholar were searched. Keywords employed included "monkeypox," "virus," "medicinal plants," "active compounds," and "mechanisms of action." Eligible sources consisted of scientific articles, dissertations, and clinical reports. Only studies directly addressing the effects of medicinal plants on monkeypox virus or their bioactive constituents were included. Non-scientific texts and unrelated publications were excluded from analysis.

Results

A range of medicinal plants with scientifically documented antiviral, anti-inflammatory, antioxidant, and immunomodulatory properties against monkeypox virus (MPX) were identified. Among these are *Allium sativum, Adansonia digitata, Azadirachta indica, Boscia senegalensis, Carica papaya, Cissus populnea, Cucurbita maxima, Ficus platyphylla, Lawsonia inermis, Maytenus senegalensis, Moringa oleifera, Olea europaea, Sterculia setigera, Acacia nilotica, Anogeissus leiocarpus, Balanites aegyptiaca, Calotropis procera, Cassia singueana, Citrullus lanatus, Diospyros mespiliformis,* and *Ficus polita*.

The therapeutic effects of these plants are largely attributed to their diverse bioactive constituents, such as flavonoids, saponins, tannins, and alkaloids. These compounds have the capacity to interfere with viral replication, modulate immune responses, and mitigate inflammation, thereby offering potential in preventing or managing monkeypox infection. A comprehensive summary of the plants and their mechanisms of action is presented in Table 1.

Table 1: Medicinal plants with potential effects against monkeypox virus (MPXV)

Scientific name	Plant family	Mechanism of action	Bioactive compounds	Plant part used	Mode of use	Ref.
Allium sativum L.	Amaryllidaceae	Antiviral, immunostimulant	Allicin, ajoene	Bulb (clove)	Oral, crushed in food	[16]
Adansonia digitata L.	Malvaceae	Antioxidant, anti-inflammatory	Vitamin C, flavonoids	Fruit pulp (powder)	Oral (dried powder)	[17]
Azadirachta indica A. Juss	Meliaceae	Antiviral, immune booster	Nimbidin, azadirachtin	Leaf, stem bark	Decoction, powder, topical paste	[18]
Boscia senegalensis (Pers.) Lam.	Capparaceae	Antimicrobial, antiviral	Tannins, saponins	Leaf, bark	Decoction, infusion	[19]
Carica papaya L.	Caricaceae	Antiviral, digestive tonic	Papain, flavonoids	Leaf, unripe fruit	Leaf extract, decoction	[20]
Cissus populnea Guill. & Perr.	Vitaceae	Antioxidant, anti-inflammatory	Polyphenols, resveratrol	Root, bark	Decoction, maceration	[21]
Cucurbita maxima Duchesne ex Lam.	Cucurbitaceae	Antioxidant, immune booster	Carotenoids, vitamin C	Fruit pulp	Oral	[22]
Ficus platyphylla Delile	Moraceae	Antimicrobial, antioxidant	Flavonoids	Leaf, stem bark	Decoction	[23]
Lawsonia inermis L.	Lythraceae	Antiviral, antimicrobial	Lawsone, flavonoids	Leaf	Topical poultice, decoction	[23]
Maytenus senegalensis (Lam.) Exell	Celastraceae	Antimicrobial	Alkaloids, flavonoids	Root, leaf	Decoction, extract	[23]
Moringa oleifera Lam.	Moringaceae	Anti-inflammatory, immune booster	Moringin, glucosinolates	Leaf, seed	Leaf powder, infusion	[24]
Olea europaea L.	Oleaceae	Antioxidant, anti-inflammatory	Oleuropein	Leaf, fruit (oil)	Leaf infusion, topical oil	[25]
Sterculia setigera Delile	Malvaceae	Antiviral	Saponins	Stem bark	Decoction	[26]
Acacia nilotica (L.) Willd.	Fabaceae	Antimicrobial	Tannins, flavonoids	Bark, dried fruit	Decoction, gargle	[27]
Anogeissus leiocarpus (DC.) Guill. & Perr.	Combretaceae	Anti-inflammatory, antimicrobial	Tannins, flavonoids	Leaf, bark	Decoction	[28]
Balanites aegyptiaca (L.) Delile	Zygophyllaceae	Antimicrobial	Saponins	Fruit, seed	Oil, decoction	[19]
Calotropis procera (Aiton) W.T. Aiton	Apocynaceae	Anti-inflammatory, antiviral	Calotropin, latex	Leaf, sap	Topical (with caution)	[19]

Cassia singueana Delile	Fabaceae	Antimicrobial, digestive tonic	Flavonoids, sennosides	Root, leaf	Decoction	[19]
Citrullus lanatus (Thunb.) Matsum. & Nakai	Cucurbitaceae	Hydrating, antioxidant	Citrulline, lycopene	Fruit, rind	Oral, extract	[28]
Diospyros mespiliformis Hochst.	Ebenaceae	Antimicrobial, antioxidant	Tannins	Leaf, bark	Decoction, infusion	[29]
Ficus polita Vahl	Moraceae	Antimicrobial, immune booster	Flavonoids, tannins	Leaf, bark	Decoction	[29]

In this study, medicinal plants were analyzed in terms of family frequency, mechanisms of action, plant parts used, and modes of administration. The results revealed that Malvaceae, Cucurbitaceae, Fabaceae, and Moraceae were the most frequently represented families, while the predominant mechanisms of action included antimicrobial, antioxidant, antiviral, and anti-inflammatory activities. Leaves were identified as the most commonly used plant part, and decoctions emerged as the most frequently employed method of administration. These findings highlight a clear preference for leaves and woody plant parts, as well as a traditional inclination toward oral consumption and the preparation of extracts and decoctions in pharmacological and ethnobotanical practices. Additional information regarding this aspect is presented below:

In the present study, Malvaceae, Cucurbitaceae, Fabaceae, and Moraceae were identified as the most frequently occurring families, each represented twice among the plants examined. The remaining families Amaryllidaceae, Meliaceae, Capparaceae, Caricaceae, Vitaceae, Lythraceae, Celastraceae, Moringaceae, Oleaceae, Combretaceae, Zygophyllaceae, Apocynaceae, and Ebenaceae were each observed only once.

In the present study, the most prevalent mechanisms of action among the plants examined included antimicrobial, antioxidant, antiviral, and anti-inflammatory activities. In addition, immunostimulatory and digestive-supporting mechanisms were also identified. Hydrating activity was observed only to a limited extent, highlighting the diverse pharmacological profiles of these plants.

Among the plants examined, leaves were the most frequently used part, followed by bark and fruits including pulp, rind, and oil. Other parts, such as roots, stem bark, seeds, as well as bulbs (cloves), sap, unripe fruits, and dried fruits, were each utilized only once. This distribution reflects a clear preference for leaves and woody parts in pharmacological studies.

Among the plants examined, decoction was the most frequently employed method of administration, followed by oral use and various topical applications, which were observed with moderate frequency. Other methods, including infusion, extract, leaf powder, oil, maceration, and gargle, were used less frequently. This distribution reflects a clear preference for oral consumption and the preparation of decoctions and extracts in the traditional use of medicinal plants.

Discussion

Monkeypox, as a viral disease with high transmissibility and diverse clinical manifestations, necessitates the development of effective and safe therapeutic strategies. In this regard, medicinal plants with antiviral, anti-inflammatory, and immunomodulatory properties present themselves as valuable complementary or alternative options. The table presented in this study outlines a wide range of plants, each containing distinct bioactive constituents and demonstrating unique mechanisms of action against the monkeypox virus and its associated complications. *Allium sativum*, for example, contains compounds such as allicin and ajoene that play a critical role in immune enhancement and antiviral activity. These agents act by stimulating immune cells and suppressing viral replication, thereby contributing to the reduction of viral load [30]. Similarly, plants such as Boscia senegalensis and Olea europaea, rich in tannins and oleuropein respectively, exhibit antimicrobial, antiviral, and antioxidant properties that help to reduce inflammation and limit oxidative damage [31,32]. Flavonoids, present in many of these plants, are especially important in modulating inflammation and strengthening immune responses. They inhibit inflammatory pathways and activate endogenous antioxidants, thereby protecting cells from damage associated with inflammatory reactions. Adansonia digitata and Cissus populnea, both abundant in flavonoids, exert antioxidant and anti-inflammatory effects that accelerate the healing process [34,35]. In addition to antiviral and anti-inflammatory benefits, certain plants contribute to the general strengthening of body systems. For instance, *Cucurbita maxima*, with its high content of vitamin C and carotenoids, enhances the body's resistance to infections. This systemic immune support, combined with direct antiviral action, amplifies the overall therapeutic efficacy [36]. With respect to routes of administration, many of these plants are traditionally consumed in the form of decoctions, infusions, or extracts, which remain common practices for harnessing their therapeutic potential. In some cases, topical applications have also been documented; for example, olive oil or poultices made from *Lawsonia inermis* leaves are employed for their local antimicrobial and antiviral effects in alleviating monkeypox-associated skin lesions [37]. Ultimately, the broad spectrum of bioactive compounds and diverse mechanisms ranging from viral inhibition and anti-inflammatory activity to immune modulation and oxidative stress reduction underscores the importance of advancing research in this area. In contexts where synthetic pharmaceuticals may cause adverse effects or be inaccessible, medicinal plants hold particular promise as effective complementary therapies [38–40].

Conclusion

The findings of this review highlight the therapeutic potential of medicinal plants containing a wide variety of bioactive compounds with antiviral and immunomodulatory activities. These plants can serve as effective complementary options for the management of monkeypox by alleviating symptoms and reducing viral load. However, rigorous scientific investigations, including preclinical and clinical studies, remain essential to establish their efficacy and safety. Further exploration of these traditional remedies, in parallel with modern medical approaches, may provide a valuable foundation for integrative strategies to manage future outbreaks of monkeypox.

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Statements and Declarations

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Author Contributions

AR contributed to the conceptualization, literature search, data collection, and drafting of the manuscript. SKM supervised the study, provided critical revisions, and finalized the manuscript.

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