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# Phytochemical Profile and Pharmacological Potentials of Plumeria Species: A Comprehensive Review

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**ABSTRACT:** The recent trend of shifting to conventional or natural practices in the medical world indicates that people are inclining toward a healthier lifestyle. Medicines manufactured from natural resources like plants are believed to have fewer adverse effects than synthetic ones. Numerous illnesses have an impact on people's daily lives. To address these diseases and reduce adverse effects, new plant-based treatments must be introduced. One such genera of plants whose medicinal properties have paved the way to extensive research to treat various diseases is the genus Plumeria which is abundantly available in India, tropical America, and Brazil. This article reviews the research conducted on the above plants and summarises the main findings of that research. The research papers were accessed using various web platforms such as Academia, Elsevier, and Google Scholar. The species of Plumeria were found to be anti-fertile, anti-diarrheal, anti-inflammatory, anti-microbial, anti-pyretic, and anti-ulcerative. Plants of the genus Plumeria are now a novel and potent source that can be integrated into various formulations because of these activities. Thus, this article discusses various phytochemical characters and pharmacological uses of the Plumeria species (Plumeria rubra, Plumeria acuminata, Plumeria alba). The different parts of these plants such as leaves, bark, and flowers can be used to treat several diseases.

**KEYWORDS:**Plumeria rubra, Plumeria acuminata, Plumeria alba, anti-inflammatory, anti-fertility, antipyretic, anti-fungal, and phytoconstituents.

## I. INTRODUCTION

- **Plumeriarubra**:

[1,2].Plumeria rubra, a member of the Apocynaceae family, is a vibrant flowering tree widely found in Mexico, Colombia, Central America, Venezuela, India, and Hawaii.

Plumeriarubra

[2]. Commonly known as Lal Champa in Hindi and frangipani or red jasmine in Englishthis plant is cherished for its ornamental beauty and medicinal significance. One of its most distinctive features is the milky latex that oozes from the stem when its leaves are plucked. The tree's leaves are arranged in an elegant spiral pattern, with an oblong, elliptic, or ovate shape and an acuminate tip. Its fragrant flowers, which bloom from August to October, are typically pink or red, adding to the tree's striking appearance.

[1, 3].Beyond its aesthetic appeal, Plumeria rubra has been widely used in traditional medicine. Different parts of the plant offer diverse therapeutic benefits:

- Leaves help reduce inflammation and heal ulcers.
- Bark is known for its purgative and stimulant properties and has been used to treat jaundice and amoebic dysentery.
- Milky latex is applied for fever, skin itches, diarrhea, and inflammatory conditions.
- Flowers are believed to help manage diabetes and soothe whooping cough.
- [4][1]. Root bark exhibits anti-pruritic, anti-ulcerative, anti-gonorrheal, and anti-leprotic properties.
- [5].Its taxonomical classification is as follows:

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| | |
|---|---|
| Kingdom | : Plantae |
| Subkingdom | : Tracheobionta |
| Superdivision | : Spermatophyta |
| Division | : Magnoliophyta |
| Class | : Magnoliopsida |
| Subclass | : Asteridae |
| Order | : Gentianales |
| Family | : Apocynaceae |
| Genus | :Plumeria L. |
| Species | :rubra |

- **Plumeria acuminata**:

[6].Plumeriaacuminata, a member of the Apocynaceae family, thrives in tropical regions worldwide, including India, Southeast Asia, and the Americas.In southern India, it is affectionately known as "Champa," a name that reflects its deep cultural significance.

[7, 8].This small yet resilient tree is distinguished by its abundant milky latex, which has long been valued for its anti-inflammatory and anti-rheumatic properties. At the tips of its branches, clusters of oblong-shaped leaves form a dense canopy. Interestingly, its branches are believed to have abortifacient properties, while its leaves have been traditionally used as purgatives and for treating inflammation and rheumatism.


Plumeriaacuminata

[6].The flowers of Plumeria acuminata are another striking feature. Their fragrant, bisexual blooms display a white upper portion with a yellow lower side, creating a visually stunning contrast. Beyond their beauty, these flowers also possess strong antifungal properties, making them valuable in traditional medicine. The tree produces ellipsoid, brownish-black fruits that contain oblong seeds, further contributing to its botanical uniqueness. With its versatile medicinal applications and widespread cultural use, Plumeria acuminata continues to be an important plant in herbal medicine, warranting further scientific exploration into its therapeutic potential.

[5].Itstaxonomical classification is given below.

| | |
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| Class | : Magnoliopsida |
| Subclass | : Asteridae |
| Order | : Gentianales |
| Family | : Apocynaceae |
| Genus | :Plumeria L. |
| Species | : acuminata |

- **Plumeria alba**:

[5]. Like its counterparts, Plumeria alba belongs to the Apocynaceae family and is cherished for both its ornamental beauty and medicinal properties.[8]Native to Central America and the Caribbean, this plant is often seen adorning gardens and temples with its delicate, fragrant white flowers.Unlike its taller relatives, P. alba is a short, lactiferous shrub or tree, producing a milky sap when its bark or leaves are cut.[9, 10]This thin-barked tree has been widely used in traditional medicine, where its bark serves as a purgative and febrifuge, helping to cleanse the digestive system and reduce fever. Its latex has also been applied as a rubefacient (a substance that increases blood flow to the skin), as well as a purgative, and is used to treat ulcers, scabies, herpesand can be used as anti-filarial.[11]Beyond these uses, Plumeria alba has shown promise in supporting cardiovascular health, with studies suggesting its potential cardiotonic and hypotensive (blood pressure-lowering) effects. With its broad spectrum of medicinal properties, this plant remains a valuable subject of scientific research, further bridging the gap between traditional healing and modern pharmacology.

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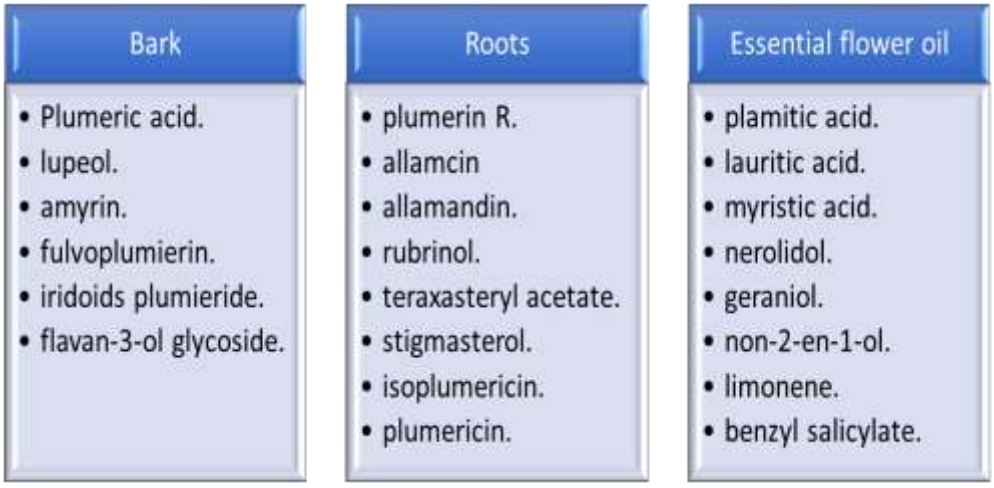
| Subclass | : Asteridae |
| Order | : Gentianales |
| Family | : Apocynaceae |
| Genus | :Plumeria L. |
| Species | :alba |

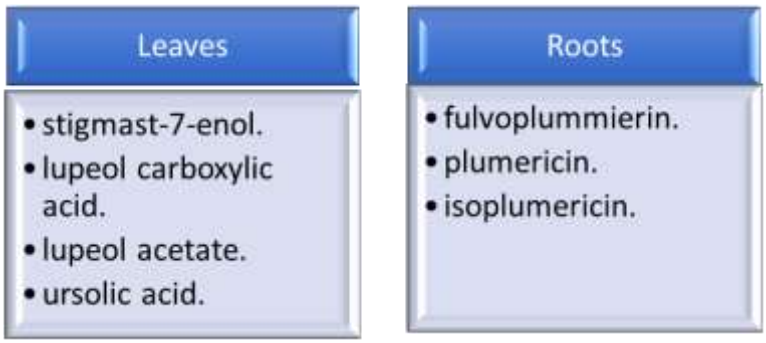
## II. PHYTOCHEMICAL SCREENING OF EXTRACTS

The phytochemical screening of the above-said plants was conducted by various researchers.

**Plumeriarubra:**[1, 5, 12]. Studies on the methanolic extract of Plumeriarubra have identified a diverse range of phytoconstituents present in its bark, roots, and essential flower oil.These compounds play a crucial role in the plant's therapeutic effects, contributing to its anti-inflammatory, antimicrobial, and antioxidant properties.




**Plumeriaacuminata**: [5, 6, 7, 12]. The leaves of P. acuminata were extracted with petroleum ether, toluene, chloroform, ethyl acetate and methanol.It also seemed to possess some essential oils such as geraniol, citronellol, and farnesol. The phytochemicals present in the leaves and roots are given below.




**Plumeriaalba**: [5, 11, 13]. The various chemical extracts of the leaves of P. alba were also found to possess the same phytoconstituents as the leaves of P. acuminata.The phytoconstituents present in the extracts of roots, barks and whole plant is given below.

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| Leaves: | Root and Bark: | Whole plant: |
|---|---|---|
| •stigmast-7-enol.<br>•lupeol carboxylic acid.<br>•lupeol acetate.<br>•ursolic acid. | •iridoids.<br>•tannins.<br>•alkaloids.<br>•fulvoplumierin.<br>•allamcin.<br>•allamandin.<br>•2,5-dimethoxy-p-benzoquinone.<br>•plumericin.<br>•lignanliriodinndrin. | •mixture of amyrins.<br>•plumeride.<br>•iriddoidsisoplumericin.<br>•plumeridecoumerate.<br>•plumeridecoumerateglucoside. |

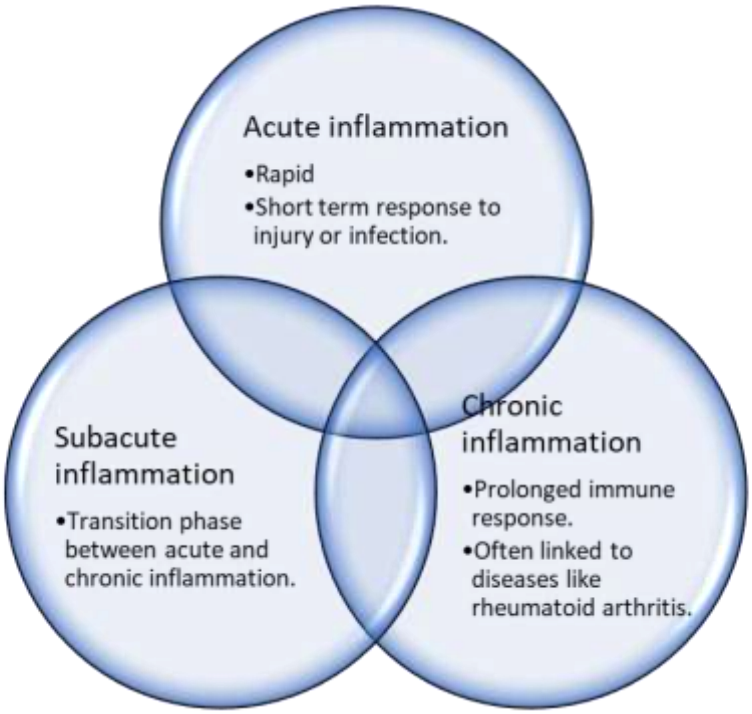
## III. PHARMACOLOGICAL EFFECTS:

The above-mentioned species of the Genus Plumeria possess various pharmacological actions. Some of them are Anti-inflammatory, anti-fertility, anti-pyretic and anti-fungal activity. The experimental procedures and mechanisms involved in the activities shown by the Genus Plumeria are discussed below:

**Anti-inflammatory activity**:

[14]. Inflammation is the body's natural defence mechanismand a complex biological response triggered by pathogens, irritants, or injury. It plays a crucial role in protecting tissues and initiating healing. However, when inflammation becomes excessive or prolonged, it can contribute to chronic diseases such as arthritis, cardiovascular conditions, and autoimmune disorders.

[14]. The classic 5 signs of inflammationinclude calor (heat), rubor (redness), d olor (pain), tumour (swelling), and functio-laesa (loss of function) reflect the body's attempt to isolate and eliminate harmful agents. Based on its duration and severity, inflammation is categorized into three types.




To manage inflammatory conditions, researchers continuously explore plant-based anti-inflammatory agents as alternatives to synthetic drugs. Among them, Plumeria acuminata has

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emerged as a promising candidate due to its rich phytochemical composition.

[8, 15].The methanolic extract of Plumeria acuminata demonstrated significant anti-inflammatory effects in both acute and chronic inflammation models. It reduced paw edema induced by carrageenan, dextran, histamine, and serotonin, with results comparable to indomethacin. Additionally, it inhibited granuloma formation in the cotton pellet-induced inflammation model, indicating effectiveness in chronic inflammation. The extract was well tolerated, with an LD50 exceeding 2 g/kg, suggesting a favorable safety profile.

[16]. Similarly, the methanolic extract of Plumeria rubra exhibited anti-inflammatory activity, particularly at 500 mg/kg, in carrageenan-induced paw edema and cotton pellet-induced granuloma models. Additionally, a saponin extract of P. rubra at 200 mg/kg also reduced inflammation in albino mice.

[17]. The anti-inflammatory effect of MEPA was calculated by the following equation:- Anti-inflammatory activity (%) = (1-D/C) × 100, where D represents the percentage difference in paw volume after the administration of drugs to the rats and C represents the percentage difference of volume in the control groups.

[8]. Anti-inflammatory mechanism:Inflammation occurs when the body detects harmful stimuli, such as infections, injuries, or foreign substances. These triggers activate specialized molecular sensors, which, in turn, stimulate the release of inflammatory mediators. These mediators—chemical compounds like histamine, serotonin, and prostaglandins—are responsible for initiating pain, swelling, and immune cell recruitment.One of the most significant findings was that the methanolic extract of Plumeria acuminata demonstrated an anti-inflammatory effect comparable to indomethacin, a well-known nonsteroidal anti-inflammatory drug (NSAID). Indomethacin works by inhibiting prostaglandin synthesis via the arachidonic acid pathway, blocking cyclooxygenase (COX) enzymes, which are critical in the inflammatory process.

With their high safety profile and notable anti-inflammatory effects, Plumeria acuminata and Plumeria rubrapresent an exciting opportunity for developing natural, plant-based alternatives to conventional anti-inflammatory medications.

**Anti- fertility activity**:

[18, 19].Controlling fertility is crucial to uphold acceptable standards in emerging nations. In the current environment, a contraception that is affordable, safe, effective, and widely accepted is desperately needed. Thus, fertility control has emerged as the primary care for the world's inhabitants. Therefore, several strategies are being employed to lower the overall fertility rate for both men and women. However, because of insufficient fertility inhibition or adverse effects, the quest for an oral effective and safe plant preparation is still ongoing.According to reports, a few plants may have antifertility properties, and only a tiny number of these have advanced to the point of clinical assessment. Therefore, there is a need to find herbal pharmaceuticals that can disrupt the hypothalamus pituitary-gonadal axis's endocrine function to replace synthetic steroidal and nonsteroidal medications as birth-control management tactics. Anti-fertility refers to anything that can prevent pregnancy or reduce fertility.

[7, 20].Researchers are now interested in the potential of Plumeria acuminata and Plumeria rubra, whose leaves and roots contain chemicals that may have these benefits. Stigmasterol, which shares structural similarities with estrogen, is one of the plant's main constituents. It can therefore affect the body in ways that are both estrogen-like and estrogen-blocking. In addition to this, Plumeria acuminata contains saponins, which are believed to prevent fertilization and implantation, and also help regulate hormones like FSH (follicle-stimulating hormone) and LH (luteinizing hormone), both of which are involved in the female reproductive cycle. The plant also has flavonoids, which are plant-based compounds that act like estrogen, and these have been shown to reduce sperm count in male rats.

[7, 21].The four oestrous cycle stages in rats are pro-oestrous phase, oestrous phase, meta-oestrous phase, di-oestrous phase.

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The research on Plumeria acuminata[7] and Plumeriarubra[18, 19]examined their potential as male contraceptives and abortifacients. [7] In the case of Plumeria acuminata, the methanolic extract administered to male albino rats in different doses for 60 days led to a significant decrease in the weight of reproductive organs like the testes and epididymis, and a reduction in sperm count, indicating anti-spermatogenic effects. Histopathological analysis showed damage to testicular tissue, supporting the extract's role in impairing spermatogenesis.

[18, 19].Similarly, in Plumeria rubrathe methanolic bark extract also caused a significant reduction in the weights of testes, epididymis, and accessory sex organs at various doses (50, 100, 200 mg/kg). A fertility test revealed a dose-dependent decrease in fertility, with the highest dose (200 mg/kg) resulting in complete infertility.These findings suggest that Plumeria rubra acts through similar mechanisms, likely by disrupting hormonal balance and inhibiting sperm production. Both plants show promise as male contraceptive agents through their effects on the reproductive system.

**Anti-pyretic activity**:

[22].Elevation of the core body temperature above a set-point' controlled by the hypothalamic thermoregulatory center is known as pyrexia or fever. The set-point temperature of the body is frequently raised by a physiological process that can be caused by an infectious or non-infectious factor, such as inflammation, cancer, or autoimmune reactions. Immunological mediators are released during these processes, which activate the hypothalamic thermoregulatory center and raise the body's core temperature.

[3]. When the body detects an infection, the affected tissues release inflammatory substances that stimulate the production of prostaglandin E2. This hormone then signals the hypothalamus, the part of the brain that controls temperature, to raise the body's heat. Although fever helps the body battle infections, it can also speed up the progression of diseases. Anti-pyretic agents are substances that work to lower fever and restore the body's normal temperature.

[23]. The results of research on Plumeria rubra Linn. shows that the methanolic extract of the plant has strong antipyretic and maybe holding hypothermic properties. Two different models of fever were used for the evaluation: the Prostaglandin E1 (PGE1)-induced pyrexia model and the Typhoid vaccine-induced fever model. The methanolic extract of Plumeria rubra showed notable efficacy in lowering raised body temperatures in both models, indicating its antipyretic qualities and potential for medicinal use in the treatment of fever.

[23]. In the typhoid vaccine-induced fever modelrabbits were first given the vaccine, which caused fever, and then they were treated with Plumeria rubra extract. One group of rabbits received saline as a control, while the other groups received different dosages of the methanolic extract, which were 100 mg/kg and 200 mg/kg body weight, respectively. The animals were suffering from severe pyrexia when the extract was given orally 60 minutes after the typhoid vaccine was delivered. The findings showed that after receiving both dosages of Plumeria rubra extract, the rabbits' body temperatures were considerably lowered. The impact was nearly identical to that of the conventional antipyretic medication, paracetamol, which was employed as a comparison,

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at the greater dosage (200 mg/kg). Though not as profound as the 200 mg/kg dose, the lesser dose of 100 mg/kg also exhibited noteworthy outcomes. These results imply that the methanolic extract of Plumeria rubra may help reduce fever, especially in cases when bacterial infections are the cause, like in the case of typhoid vaccination.

[23]. In the second model, known as PGE1-induced pyrexia, rabbits were given PGE1, a prostaglandin analogue, to make them feverish. PGE1 was injected into the rabbits in this model after they had been acclimated, and this consistently raised their body temperature. The mice were split up into groups, much like in the previous model, and given either saline (as a control), aspirin (a well-known antipyretic), or different amounts of Plumeria rubra methanolic extract (100 mg/kg and 200 mg/kg). One hour after the PGE1 injection, the extract was taken orally, and throughout four hours, the body temperature was taken at one-hour intervals. The plant's antipyretic properties are thought to be attributed primarily to flavonoids. Cyclooxygenase (COX), an enzyme involved in the synthesis of prostaglandins that mediate fever and inflammation, is inhibited by these substances. The plant's antipyretic effects appear to be due to the inhibition of prostaglandin synthesis, which aligns with the pharmacological activity of standard antipyretic drugs like aspirin. The presence of flavonoids and other bioactive compounds in the plant further supports this mechanism of action. The results suggest that Plumeria rubra could serve as a potential natural remedy for the treatment of fever, providing an alternative to conventional synthetic drugs. Additionally, its non-toxic profile makes it a safe option for therapeutic use, further strengthening its potential for future development as a natural antipyretic agent.

[3]. Another study explored the fever-reducing potential of Plumeria rubra leaf extract, comparing it to aspirin. Researchers induced fever in albino rats using boiled milk and tested the extract at 200 mg/kg against aspirin (10 mg/kg). The extract significantly lowered body temperature from 104.4°F to 101.3°F within three hours, showing a response close to aspirin (104.3°F to 101.1°F). With an LD50 of 1000 mg/kg, the extract was found to be safe at the tested dose. These findings suggest that P. rubra leaves contain bioactive compounds with promising antipyretic effects.

**Anti-fungal activity**:

[24]. Fungal infections are among the most common types of infections affecting a wide range of living organisms, including humans, animals, and plants. Antifungals are compounds that either eradicate or prevent the growth of the spores or fungi that cause infection. It has been used for food preservation and as a chemical-free substitute.

[11]. Plumeria alba, a plant known for its beautiful white flowers with a yellow center, is one such plant believed to possess anti-fungal properties. These fragrant flowers contain essential oils that are said to help combat fungal infections. The oils are rich in compounds like geraniol, citronellol, farnesol, phenyl ethyl alcohol, and linalool, which are known for their antimicrobial effects. Additionally, the flowers of P. albaare packed with flavonoids such as quercetin and kaempferol, both of which have demonstrated various medicinal benefits, including antifungal activity.

Anti-Fungal Activity of Plumeriaalba Essential Oil: [11, 25, 26]. The essential oil from Plumeria alba flowers was tested against several fungal strains using the minimum inhibitory concentration (MIC) method and the disc diffusion method. The oil exhibited significant antifungal activity, particularly against Candida albicans and Aspergillusniger.Below table gives details about MIC of Plumeriaalba essential oil against fungal Strains.

| **Fungal species** | **MIC (µg/ml)** |
|---|---|
| Candida albicans (ATCC 10231) | 125 |
| Candida albicans (5) | 100 |
| Aspergillusniger (MTCC 281) | 50 |
| Penicilliumchrysogenum (MTCC 2725) | 75 |
| Phaenorochaetechrysosporium(MTCC 787) | 100 |
| Ralstoniaentropha (MTCC 1255) | 150 |

Antifungal Activity of Methanol Flower Extract:[27, 28]. The methanol extract of Plumeria alba flowers was evaluated for antifungal activity against Trichoderma spp. at different

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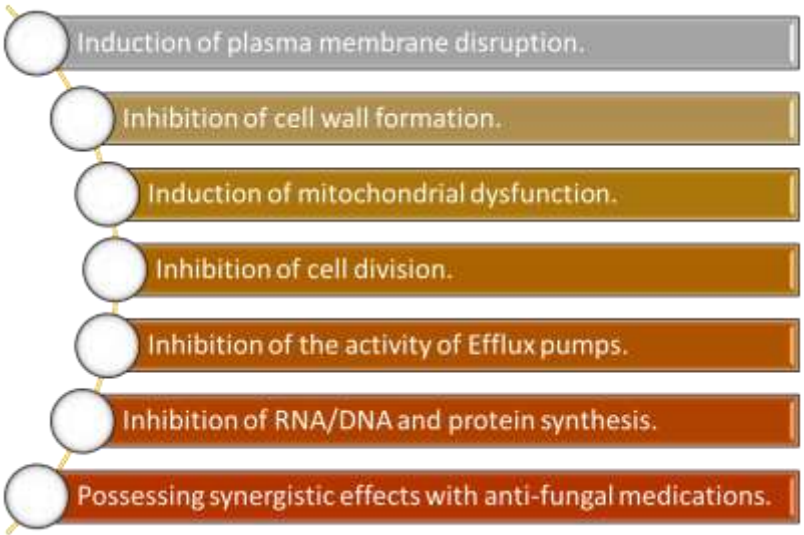
concentrations. The extract demonstrated effective antifungal activity, with growth inhibition ranging from 7–97%, depending on the fungal species and concentration.Growth inhibition percentage of fungal species treated with methanol extract in different concentrations is given below.

| Fungal species | 50 (µg/ml) | 125 (µg/ml) | 250 (µg/ml) | 500 (µg/ml) |
|---|---|---|---|---|
| T. viride | 31% | 52% | 70% | 90% |
| T. hamatum | 7% | 28% | 55% | 77% |
| T. koningii | 9% | 36% | 58% | 76% |
| T. reesei | 11% | 45% | 68% | 97% |

Antifungal activity of isolated leaf extract of Plumeriaalba: [28, 29]Leaf extracts of Plumeria alba were prepared using various solvents and tested for antimicrobial activity. The methanol extract exhibited significant antifungal activity particularly against Aspergillusniger and Penicilliumchrysogenum. The antifungal activity of the methanol extract and its isolated triterpene fraction was comparable to the standard antifungal agent, clotrimazole. The MIC of the extract and isolated fraction against fungi was found to be 50–125 µg/mL, suggesting that triterpenes play a key role in the antifungal effects. [28] The MIC of these substances werecompared to clotrimazole for several fungal species like A. niger, P. chrysogenum, E. floccosum, M. gypseum. Overall, both the methanolic extract and isolated fraction of Plumeria alba demonstrate moderate antifungal activity against the tested fungal species, comparable within a certain range to clotrimazole.

[28].The possible mechanisms involved in the anti-fungal effects of flavonids include:




## IV. CONCLUSION:

In conclusion, Plumeria species hold incredible promise in the world of natural medicine. With their rich variety of bioactive compounds, these plants have shown potential in addressing a range of health concerns, from reducing inflammation and combating fungal infections to offering antifertility and fever-reducing benefits. As research into Plumeria deepens, we're likely to see more groundbreaking discoveries that could lead to innovative treatments. The future of plant-based medicine is bright, and Plumeria could very well be a key player in shaping it, offering us natural alternatives to improve health and well-being.

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