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PHARMACOLOGICAL PERSPECTIVE ON THE THERAPEUTIC POTENTIAL OF LAWSONIA INERMIS

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ABSTRACT

Henna, or *Lawsonia Inermis*, is a flowering plant indigenous to South Asia, the Middle East, and North Africa. It is a member of the Lythraceae family. The plant's most well-known product is its dried, powdered leaves, which are then used to make a natural dye. Henna is a plant with important ethnobotanical and medical uses. It has been used for a long time in its color quality and traditional medicine to treat a variety of diseases. It is spreading in tropical and subtropical regions. The antibacterial, anti-inflammatory, antioxidant, antifungal, and wound healing properties of plants are attributed to the abundance of bioactive substances, including laws, flavonoids, tannins and alkaloids. According to historical evidence, its use goes back more than 5,000 years, especially in ancient Egypt, where it was used for medical and cosmetic purposes, such as coloring garments, skin, hair, and nails. Through trade and cultural exchanges, henna moved from its initial areas of domestication to many regions of the world, including the Indian subcontinent, where it became a crucial component of traditional rites and treatment systems like Ayurveda and Unani. Because it thrives in hot climes and well-drained soils, *Lawsonia Inermis* is now grown in dry and semi-arid regions of Africa, the Indian subcontinent, and portions of the Middle East. It is a plant of international relevance due to its long-standing cultural, therapeutic, and commercial significance. In this article, the possibilities of *Lawsonia Inermis* are highlighted as a natural

source of bioactive chemicals by providing a thorough overview of its plant characteristics, phytochemistry, pharmacological activities, and therapeutic potential.

KEYWORDS: Henna, *Lawsonia Inermis*, anti-inflammatory, traditional medicine, therapeutic potential.

INTRODUCTION

Plants have long been employed as self-healing remedies by people worldwide. They continue to be the main source of medicinal compounds in underdeveloped nations today [1]. When plant components are utilized not only as direct therapeutic agents but also as drug synthesis raw materials or as models for pharmacologically active molecules, medicinal plants play a significant role in pharmacological research and drug development. Medicinal plants are often the sole therapeutic tool available to traditional healers in many parts of Africa, where they cure up to 90% of the population. Therefore, it is imperative to research these plants and offer a scientific rationale for their application [2]. Aromatic and therapeutic plants are becoming more and more popular in the health sciences, industry, and academia. Plants are now chosen for their capacity to withstand illnesses, environmental stressors, and man-made risks in addition to their production of active components. The purpose of this article is to create current research and data on many topics in relation to *Lawsonia Inermis* a facility that is prevalent in tropical and subtropical regions. Henna is found in the Indian subcontinent, the Middle east and North Africa. For thousands of years, people in North Africa and Asia have used henna. Henna grows well as a red dye and perfume in sunny climates. Henna colored textiles were used in ancient Egypt to wrap mummies. The leaves were used to create pigments in Arabia and India, with the soles of the feet, nails, fingers and palms being colored [3]. The most famous member of the Lythraceae family is *Lawsonia Inermis.* The essential color options are well-known features of this family. *Lawsonia Inermis* is a beautiful shrub with whitish bark that grows to a height of 2-6 meters. The dried leaves are 2cm long, hard, hairless and slightly wrinkled. The flowers are sticky, white or bright pink and are grouped into large ears. The leaves are smelly, with an unusual flavour and a suction touch. The fruit has many angled seeds in every compartment, small, spherical and reddish in capsules. Pharmacological studies illustrate *Lawsonia Inermis* showed properties Antibacterial, Antifungal, Antitumor and antiproliferative, Antiangiogenic, Larvicidal, Antileishmanial, Lousicide, Antimalarial, Hepatoprotective, Wound healing, Anti-inflammatory, Analgesic, Antipyretic, Memory enhancement, Enzyme inhibitor, and

Antioxidant. The current review will shed light on the biological, pharmacological, and chemical activities of *Lawsonia Inermis* and its extracts [4].

TAXONOMY

Henna is widely recognized for its therapeutic qualities, traditional body art applications, and hair coloring. According to taxonomy, it belongs to the kingdom Plantae, which denotes that it is a plant, and is further divided into groups according to its physical and genetic traits. Knowing *Lawsonia Inermis's* taxonomy makes it easier to determine its ecological role, interactions with other species, and possible applications in a range of scientific and industrial domains **[Table 1]** [5].

Table 1: Taxonomy of *Lawsonia Inermis* [6].

Taxonomy	***Lawsonia Inermis***
Kingdom	Plantae
Class	Magnoliopsida
Phylum	Magnoliophyta
Family	Lythraceae
Order	Myrtales
Species	Inermis
Genus	Lawsonia

BIOLOGICAL SOURCE

Different biological sources used for the species *Lawsonia Inermis* listed below in **Table 2,**

Table 2: Biological sources of *Lawsonia Inermis* [7].

Nomenclature	***Lawsonia Inermis***
Scientific Name	*Lawsonia Inermis*
Common Name	Henna, Egyptian privet, Mignonette tree.
Family	Lythraceae
Plant Part Used	Leaves, Seeds, Stem and Bark.
Plant Type	Flowering plant, specifically a shrub.
Origin	Originates from the Middle East, North Africa and Southern Asia specifically the Indian subcontinent.

MORPHOLOGICAL CHARACTERISTICS

Baum

Grows up to 4.9-13.1 feet (1.5-4 meters). CM (0.8-1.6) inch length.

Surface: Dark green [8].

Flowers

Type – Small, bisexual and funnel – Fisn style

Color – White or pale yellow [9].

Arrangement – Four chal-vier- Camper van – Chail Fertilization

Feel Flower – It has an excellent ovary with four sailing flaps, four petals and four cells [10].

Fruit

Type - Dried Dehisced fruit

Size – 4.8mm (0.16 - 0.32) inches (Many seeds per fruit) [11].

Figure 1: Morphological characters of *Lawsonia Inermis* [11].

CHEMICAL CONSTITUENTS

A wide variety of chemical elements found in the leaves, bark, seeds, and roots of plants support their many biological activities. Lawsone, flavonoids, tannins, phenolic compounds, alkaloids, and terpenoids are the main bioactive substances [12]. The antibacterial, anti-inflammatory, antioxidant, and dyeing qualities of *Lawsonia Inermis* are attributed to these components. Knowledge of these chemical constituents sheds light on the medicinal possibilities and conventional uses of this adaptable plant **(Table 3)** [13].

Table 3: Chemical Constituents of *Lawsonia Inermis* [14].

SI.No.	Phytochemical Name	Plant Part
1.	Lawsone	Leaflets, Leaf Stalks
2.	Gallic acid	Leaves
3.	Tannins	Leaves and Stems
4.	Flavonoids	Leaves, Flowers, Stems
5.	Alkaloids	Leaves
6.	Terpenoids	Leaves, Flowers, Roots
7.	Glycosides	Leaves, Flowers, Roots
8.	Saponins	Roots, Leaves
9.	Resorcinol	Leaves
10.	Coumarins	Leaves and Roots

PHARMACOLOGICAL ACTIVITIES OF *LAWSONIA INERMIS*

Lawsonia Inermis's extensive phytochemical profile, which includes substances like lawsone, flavonoids, tannins, and essential oils, has drawn a lot of interest in the field of pharmacology [15]. Numerous pharmacological activities are influenced by these bioactive ingredients. *Lawsonia Inermis* has been shown to have antibacterial, anti-inflammatory, antioxidant, analgesic, antifungal, antipyretic, antitumor, antiproliferative, antiangiogenic, wound healing, memory enhancing, Larvicidal activities, hepatoprotective qualities by scientific research [16]. *Lawsonia Inermis* is a useful plant in traditional medical systems and an interesting topic for contemporary pharmaceutical research because of these therapeutic potentials [17].

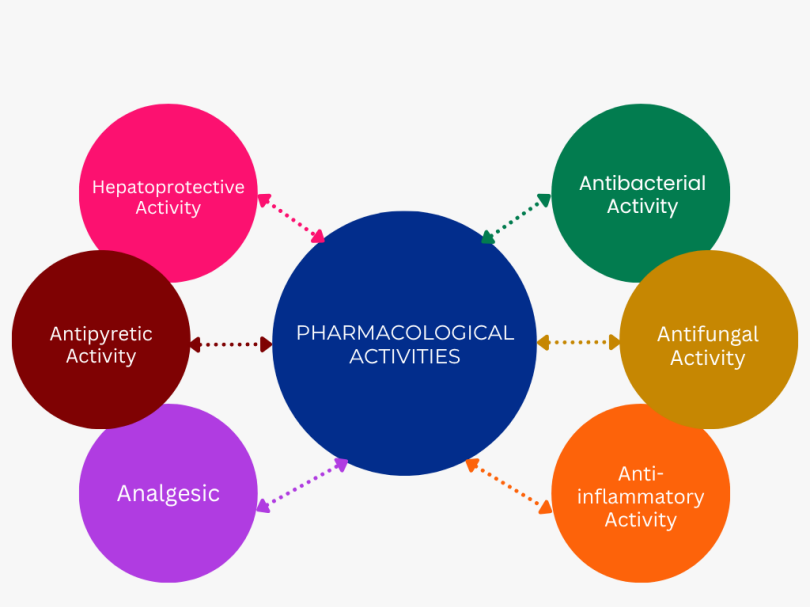

Figure 2: Pharmacological activities.

Antibacterial activity

The growing resistance of infectious diseases to existing antimicrobial drugs has created an urgent need for new, effective treatments. One promising area of research is the use of medicinal plants as natural alternatives [18]. *Lawsonia Inermis* has attracted attention for its notable antibacterial properties. Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, primarily affects the lungs and remains a significant global health issue due to the rise of drug-resistant strains, poor treatment adherence, and the need for prolonged therapy [19]. As a result, researchers are increasingly exploring plant extracts as potential sources of new antituberculosis agents. Studies have shown that acetone and hexane extracts of *Lawsonia Inermis* exhibit significant in vitro activity against the *M. tuberculosis* H37Rv strain, highlighting its potential as a natural treatment option [20].

Antifungal activity

Candida albicans, a normally harmless fungus, is a common cause of opportunistic infections affecting the skin, mouth, GI tract, and reproductive organs, particularly in women. As drug resistance rises, natural products offer new avenues for treatment [21]. *Lawsonia Inermis* (henna) has shown strong antifungal activity in various extracts. Methanolic extracts demonstrated greater inhibition against *Aspergillus terreus* and *A. flavus* than ketoconazole, and its leaf extract showed clotrimazole-like effects, fully eliminating *Candida albicans* colonies within a week [22]. Fungi from henna leaves were also found to inhibit *Staphylococcus aureus* and *Candida* growth. Bioactive compounds like alkaloids, flavonoids, and terpenoids disrupt fungal membranes, hindering growth, adhesion, and nucleic acid synthesis [23].

Anti-inflammatory activity

Chronic diseases can be caused by inflammation. This is a complex response to adverse stimuli, and the evaluation of anti-inflammatory drugs is extremely important [24]. *Lawsonia Inermis* has been shown to have important anti-inflammatory properties. According to a 2019 study, his hydroethanol extract improves epithelialization and reduces the removal of wound edges. Ethanol extract reduced edema in the carrageenan-induced inflammation model by 39.49% at 100 mg/kg and 55.98% at 200 mg/kg after 3 hours, compared to 58.13% at 10 mg/kg [25]. Methanol extracts of bark also reduced edema. The suppression of inflammatory mediators such as prostaglandins, histamines and serotonin is probably responsible for these effects [26].

Analgesic

Pain is a common medical symptom caused either by CNS nerve signals or local pain mediators like prostaglandins and histamines. *Lawsonia Inermis* has shown significant analgesic effects in animal studies [27]. Methanolic bark extracts reduced acetic acid-induced writhing and formaldehyde-induced leg licking in mice. The extract was especially effective during the second phase of formalin-induced pain, outperforming diclofenac sodium, likely due to its inhibition of inflammatory mediators like IL-1, IL-6, TNF-α, and eicosanoids [28]. Both aqueous and ethanolic leaf extracts significantly increased pain latency ($P < 0.05$), with the ethanolic extract proving more effective in reducing abdominal constriction. Additionally, a combination of *Lawsonia Inermis* and *Ricinus communis* extracts reduced mechanical allodynia, confirming strong analgesic potential [29].

Antipyretic activity

Our bodies naturally produce fevers to combat diseases. However, physicians advise managing body temperature above 38.5 °C. The reference medications for treating an excessively high fever are antipyretics [30]. According to a study by Humaish, *Lawsonia Inermis* leaf extract in ethanol has a substantial antipyretic effect that is comparable to that of ketoprofen ($P<0.05$). This resulted from a decrease in pro-inflammatory mediators, such as bradykinin and prostaglandin E2 [31].

Antitumor activity

Henna, or Lawsonia Inermis, has demonstrated encouraging antitumor and anticancer properties in a number of in vitro and in vivo investigations. Lawsone (2-hydroxy-1,4-naphthoquinone), flavonoids, tannins, and alkaloids are among its bioactive substances that are thought to be involved in these actions [32]. Extracts from *Lawsonia Inermis* can cause cancer cells to undergo programmed cell death by changing the potential of the mitochondrial membrane and activating caspase pathways. According to certain research, henna extracts can stop cancer cells at particular stages of the cell cycle, stopping their ability to proliferate. Because of the plant's potent antioxidant properties, free radicals are squelched, which lowers the rate of DNA damage and mutation [33]. It might prevent the development of new blood vessels, which are necessary for tumor growth. It can help the immune system identify and combat tumor cells more effectively. In vitro tests using cancer cell lines (including HeLa, MCF-7, and HepG2) have demonstrated that extracts from *Lawsonia Inermis* exhibit notable cytotoxicity. Following the administration of extracts, in vivo trials in animal models have shown decreased tumor growth and increased survival.

Antiproliferative activity

Lawsonia Inermis has antiproliferative action, which means it can stop cells, especially cancer cells, from growing and multiplying. Numerous phytochemicals found in the plant, particularly lawsone, flavonoids, alkaloids, and phenolic compounds, have been linked to this function [34]. *Lawsonia Inermis* extracts have been demonstrated in studies to dramatically slow the growth of a number of human cancer cell lines, including Breast cancer (MCF-7), Cervical cancer (HeLa), Liver cancer (HepG2), Lung cancer (A549), Colon cancer (HT-29). Because the active ingredients in methanolic and ethanolic extracts are more soluble, they usually exhibit stronger antiproliferative effects. It has been demonstrated that lawsone inhibits topoisomerase enzymes and intercalates with DNA. Higher concentrations and longer

exposure times provide stronger effects, and the action is frequently dose- and time-dependent [35].

Antiangiogenic Activity

An ethyl acetate extract of the terrestrial endophytic fungus *Alternaria alternata*, which was extracted from the leaves of the medicinal plant *Lawsonia Inermis* was used in a 2019 study to assess its antiangiogenic potential [36]. The investigation was carried out using the chick chorioallantoic membrane method, and the findings revealed a 32.7% suppression of angiogenesis and a substantial decrease in the number of blood vessels. On the other hand, there were more blood vessels in the Hanks Balanced Salt Solution (HBSS) control group[37].

Hepatoprotective activity

Hepatoprotective activity is the drug's ability to protect the liver from damage and improve its function. The liver is extremely important to the body as it creates bile, filters toxins, and regulates metabolism. Research into the effectiveness of *Lawsonia Inermis* and its extracts in the treatment of liver disease. Furthermore, Lawsone was able to restore livelihoods of hepatocyte HepG2 cells at a low dose of 7.5 orders of magnitude/m [38]. Furthermore, transaminase leakage and malondialdehyde levels were significantly reduced with Lawsone treatment. Butanolic extracts helped restore normal liver structure and had the advantage of strong hepatoprotection against liver lesions caused by 2-acetylamine fluorescent lesions [39]. The reduced blood activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) and lactate hydrogenase (LDH) indicates that treatment with *Lawsonia Inermis* extracts can significantly prevent carbon-induced liver. Plant continuation agents such as flavonoids, antioxidants, and anti-inflammatory compounds reduce the anti-inflammatory compounds found in *Lawsonia Inermis*, stop toxins from hepatocyte aging and degenerating hepatocytes [40].

Wound Healing Activity

The goal of the complex process of healing is to return damaged tissue to its normal form and function through a sequence of biological processes. This vital biological process, which involves intricate interactions between various cells, growth hormones, and extracellular matrix components, takes place in response to tissue damage [41]. Such action has been observed in *Lawsonia Inermis*, which has been studied for its wound-healing qualities. A study by Khan from 2021 demonstrated that hydrogel dressings made with ethanol extracts of

Lawsonia Inermis leaves helped hasten burn healing [42]. Henna's healing qualities are ascribed to the many elements found in its extract, including terpenoids, gallic acid, and flavonoids, which facilitate quicker wound closure. Furthermore, another 2020 study demonstrates that the wound from an episiotomy heals in 14 days for each of the four groups that received treatment; the henna-treated groups saw faster wound healing than the control and placebo groups [43]. The author claims that epysiotomy and pain control can be aided using some plants, including henna, as an added therapy. In Wistar rats, the ointment made from *Lawsonia Inermis* leaves shown exceptional wound-healing properties. In comparison to control, it decreased the epithelial period and wound index and increased the proportion of wound contraction ($p < 0.05$) [44]. The synergistic impact of the plant components in the oil may be the reason why wounds treated with *Lawsonia Inermis* oil for 11 days are fully closed and have the advanced tissue regeneration potential of a well-organized dermis and epidermis. Henna, Aloe Vera, Adiantum capillus-veneris, and Myrrha were found to change the gene expression signatures of Mmp3, TNF α, and TGF-β1 at the wound level created in the rat model for diabetes in a way that was consistent with rapid wound scar healing [45].

CONCLUSION

The current analysis highlights *Lawsonia Inermis's* enormous potential as a therapeutic plant by offering a thorough summary of its pharmacological and biological properties [46]. *Lawsonia Inermis* exhibits a wide range of therapeutic effects, including antibacterial, anticancer, antiproliferative, antiangiogenic, larvicidal, antileishmanial, lousicide, and antimalarial properties, as evidenced by the studies described in this article. It has also demonstrated beneficial benefits on infectious illnesses, inflammation, and wound healing[47]. These results highlight *Lawsonia Inermis's* importance as a useful resource for drug research and discovery. Future study in the fields of biology, pharmacology, and *Lawsonia Inermis* has several potential directions. To possibly find new molecules with therapeutic effect, efforts should be conducted to isolate, characterize, and identify new active chemicals from *Lawsonia Inermis*. Furthermore, in order to maximize the therapeutic uses of *Lawsonia Inermis* future research should concentrate on the sustainable use of its various sections [48]. This entails investigating extraction techniques, standardizing dosage forms, and evaluating the efficacy and safety of medicines based on *Lawsonia Inermis.* To guarantee their safe usage, studies on the toxicity profiles and possible adverse effects of *Lawsonia Inermis* extracts and isolated molecules are also essential [49]. To assess the safety, dosing schedules, and possible drug interactions, preclinical and clinical research will be

carried out. All things considered, the prospective research avenues described in this paper will offer a strong basis for additional investigation into *Lawsonia Inermis* as a significant natural bioactive chemical source. Utilizing its biological and pharmacological properties, *Lawsonia Inermis* presents numerous opportunities for the creation of novel medications and cures a range of illnesses [50].

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