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# Plant epigenetics: What it is and role in herbal field

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## Abstract

Plant epigenetics is the study of heritable changes in gene expression that do not involve changes to the DNA sequence itself. These changes are often triggered by environmental conditions and can affect plant development, stress responses, and adaptation. Epigenetics plays a crucial role in how plants regulate gene activity over time and across generations. Unlike animals, plants can pass on epigenetic information more frequently through both mitosis and meiosis. Epigenetics plays a vital role in plant biology by regulating gene expression without altering the DNA sequence. This allows plants to respond flexibly and efficiently to both internal developmental signals and external environmental conditions. In this article, the significance of plant epigenetics is explained in the fields of herbals, drug discovery and applications in crop improvement.

**Keywords:** Application, DNA, epigenetics, gene expression, plants.

## 1. Introduction

Plant epigenetics refers to the examination of heritable modifications in gene expression and functionality that do not entail changes to the fundamental DNA sequence. Rather, these modifications are facilitated by biochemical alterations to DNA, histone proteins, and non-coding RNAs, which collectively determine the activation or deactivation of genes. In contrast to genetic mutations, epigenetic modifications are reversible and can be shaped by developmental signals and environmental factors[1]. Epigenetic modifications occur through DNA methylation (the process of adding methyl groups to cytosine bases, primarily at CG, CHG, and CHH sites in plants, which generally suppresses gene expression), histone modifications (chemical alterations such as acetylation, methylation, and phosphorylation to histone proteins around which DNA is coiled, influencing the compactness of DNA packaging and gene accessibility), and non-coding RNAs (small RNAs that play a role in silencing transposable elements and regulating gene expression)[2].

Another aspect of plant epigenetics is epigenetic inheritance, which allows plants to transmit epigenetic marks across generations, even through the somatic cells, a phenomenon that is particularly significant for clonal propagation and adaptation.

In plants, this means that environmental or developmental signals experienced by a parent can lead to epigenetic changes that are stably inherited by offspring, potentially affecting their traits, stress responses, or development[3].

## 2. Importance of Epigenetics:

- Development: Controls cell differentiation and organ formation.
- Stress Response: Helps plants respond to drought, temperature extremes, and pathogens.
- In agriculture: Epigenetic changes can be harnessed for crop improvement, stress resistance, and yield enhancement without genetic modification.

## 3. Useful tools in Epigenetics:

- **Bisulfite sequencing**: For mapping DNA methylation.
- **ChIP-seq:** For detecting histone modifications.
- **RNA-seq:** To study small RNA involvement.
- **CRISPR/dCas9-based tools**: Emerging for targeted epigenome editing.

## 4. Mechanisms:

Epigenetics govern gene expression through reversible biochemical modifications that do not change the fundamental DNA sequence. The main mechanisms consist of DNA methylation, where methyl groups are attached to cytosine bases (typically in CG, CHG, and CHH contexts), resulting in transcriptional repression; histone modifications, including methylation and acetylation, which alter the chromatin structure and affect gene accessibility; and non-coding RNAs, especially small interfering RNAs (siRNAs) and microRNAs (miRNAs), which direct DNA methylation and histone modifications to specific genomic regions. Chromatin remodeling represents another crucial epigenetic mechanism that modifies the chromatin structure to control gene expression without altering the DNA sequence. The remodeling of chromatin entails repositioning, ejecting, or restructuring these nucleosomes to render specific DNA regions somewhat accessible to transcriptional machinery. This process is executed by ATP-dependent chromatin remodeling complexes (such as SWI/SNF, ISWI, CHD, and INO80 families), which utilize the energy from ATP hydrolysis to slide nucleosomes along DNA or completely evict them. These epigenetic modifications are essential for the silencing of transposable elements, the regulation of gene expression throughout development, and the capacity of plants to respond and adapt to environmental stresses. Notably, certain modifications can be reliably passed down through cell divisions and even across generations, facilitating epigenetic memory in plants. In the context of plants, chromatin remodeling plays a significant role in development, the regulation of flowering time, responses to both biotic and abiotic stresses, and the silencing of transposable elements[4, 5].

## 5. Applications of epigenetics in the herbal field and drug discovery:

Epigenetics presents promising opportunities in the realm of herbal medicine by improving the quality, yield, and therapeutic attributes of medicinal plants without modifying their genetic structure. By regulating gene expression related to the biosynthesis of secondary metabolites, epigenetic changes can affect the synthesis of essential phytochemicals such as alkaloids, flavonoids, and terpenoids, which contribute to medicinal properties. Additionally, epigenetic tools facilitate the enhancement of stress resilience in herbs, allowing them to thrive in various environments while preserving their pharmacological effectiveness. Moreover, epigenetic profiling supports the authentication and preservation of rare or endangered medicinal plant species by uncovering distinctive regulatory patterns, and epigenetic breeding methods can be employed to identify superior herbal varieties with improved therapeutic benefits, thus fostering sustainable and accurate production of herbal medicine[6, 7].

Not only that, but Epigenetics is also crucial in the realm of drug discovery as it provides innovative targets for therapeutic intervention and enhances our comprehension of disease mechanisms at the level of gene regulation. Alterations in epigenetic modifications are frequently observed in diseases such as cancer, neurological disorders, and autoimmune conditions, rendering them appealing targets for drug development. By pinpointing these epigenetic alterations, researchers can create epigenetic drugs, including DNA methyltransferase inhibitors and histone deacetylase inhibitors, which specifically counteract abnormal gene silencing or activation[8]. Furthermore, the epigenetic profiling of patient samples bolsters the concept of personalized medicine, facilitating the creation of drugs that are customized to individual epigenetic signatures. In the sphere of herbal or natural compounds, numerous plant-derived molecules are currently being investigated for their potential to influence epigenetic marks, thereby paving the way for new, safe, and effective therapeutics based on epigenetics.

## 6. Application of Epigenetics in crop improvement

Epigenetics is crucial for enhancing crop improvement by providing innovative methods to improve plant characteristics without modifying the fundamental DNA sequence. By regulating gene expressions through different mechanisms, epigenetics can affect traits including stress tolerance, flowering time, yield, and disease resistance[3]. By comprehending and manipulating these epigenetic markers, researchers can create crops that are more resilient to environmental challenges such as drought, salinity, and extreme temperatures. Furthermore, epigenetic variation can be utilized to boost genetic diversity in breeding initiatives, even in crops that exhibit limited natural genetic variation. Epigenetic markers can also act as essential instruments in marker-assisted selection, facilitating more accurate and efficient breeding. The incorporation of epigenetic strategies into traditional breeding and biotechnology presents considerable potential for sustainable agriculture and food security.

## 7. Conclusion:

Plant epigenetics provides a deeper understanding of how gene activity is regulated beyond DNA sequence alone. It opens exciting possibilities for improving agriculture, conserving biodiversity, in herbal field by understanding how plants interact with their environment in a dynamic, adaptable way and helps in new drug discovery. It is a powerful and dynamic regulatory system that enhances plant adaptability, development, and evolution and bridges molecular biology, development, evolution, and agriculture. Understanding and harnessing epigenetic mechanisms offer promising solutions for sustainable agriculture, especially in the face of climate change and increasing global food demands.

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Review Article

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# India's Unani System of Medicine: An Age-Old Healing Tradition

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## Abstract

Unani medicine entrenched in Greco-Arabic civilisations and deeply rooted in Indian cultural and medical antiquity, characterizes all-inclusive and adapted method to healthcare. Familiarized to India in the 8th century and utilized during the Mughal phase, Unani has progressed into a noteworthy constituent of India's diverse medical system. This old-style system accentuates humoral balance, lifestyle alteration, and natural medications, positioning closely with modern ethics of precautionary and integrative medicine. Nowadays, Unani relishes official acknowledgement under the AYUSH scheme and offers economical healthcare solutions, particularly in underserved societies. Despite its healing significance and historical deepness, Unani faces challenges linked to consciousness, calibration, and incorporation with modern medicine. This article focuses the historical development, fundamental principles, existing applications, and forthcoming potential of Unani medicine in India, contending for its revival through general awareness, committed research, dedicated education, funding and policy support.

**Keywords:** Unani medicine, Ilm-ul-Advia, conventional healing, humoral concept, AYUSH.

## 1. Introduction

Unani, which translates to "Greek," refers to an ancient Greek medical system that was founded on the four humors and temperaments. Unani medicine acknowledges the physical, mental, emotional, and spiritual factors that contribute to health or illness and holds that each person should oversee their own health.

Claudius Galenus of Pergamum, who lived in the second century of the common era, is credited with creating the principles that make up Unani healing. Hakin Ibn Sina, often known as Avicenna, gathered the fundamentals of Unani medicine as a therapeutic system in Persia in 980 CE.

Ajmal Khan, who was born in India in 1868, is subsequently widely regarded as the most important contributor to Unani medicine in India throughout the 20th century[1]. Like Western medicine, Unani medicine has its roots in Hippocrates and his disciples. In India, Pakistan, and Persia, the Unani medicine is widely used. England, South Africa, and other nations also practice it. Hikmat and Unani-Tibb are other names for the Unani system.

With origins in Greco-Arabic customs, Unani medicine is an age-old healing system that has thrived in India for millennia and woven itself into the country's diverse medical landscape.

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The holistic approach to health known as Unani, or "Ilm-ul-Advia" (the science of medicines), places a strong emphasis on temperament, balance, and the interaction of the body, mind, and environment. With its ability to combine cultural history with therapeutic significance. Unani medicine occupies a special niche in India, where various medicinal systems coexist[2]. Given the escalating expenses and adverse effects of contemporary healthcare, Unani medicine focus on natural medicines, preventive care, and customized therapy presents a strong alternative that merits reexamination and incorporation into the mainstream medical system.

### 1.1. Four elements of Unani Medicine System

The four elements namely fire, water, earth, and air are the foundation of Unani medicine. All facets of life and the body contain these components. Health results from their balance, whereas illness results from their imbalance. There are similarities between the four elements of Unani medicine and Ayurvedic medicine.

### 1.2. Four types of temperament

The cornerstone of Unani medicine is the concept of the four temperaments. The four elements plus the characteristics of heat, moisture, cold, and dryness, in particular proportions, make up everything in the cosmos, whether it be a mineral, plant, animal, or human. Every object, chemical, or living thing has an equilibrium state that reflects these attributes, depending on the ratios of these components. "Temperament" refers to the equilibrium of attributes[3]. The four temperaments are categorized as melancholy (cold and dry), bilious (hot and dry), phlegmatic (cold and moist), and sanguinous (hot and moist). A particular temperament will predominate in each person and organ system. The bodily fluids, commonly referred to as humors, are created from food and beverages and are in charge of preserving temperamental equilibrium. The same characteristics are used to categorize these humors.

### 1.3. Factors related to lifestyle

Disease can be avoided and health preserved by selecting and controlling lifestyle factors. The following lifestyle factors are suggested by Bhikha[4]:

**1.3.1. *Drinks and food*:** Consuming enough water and food on a regular basis to keep you hydrated and in balance with your temperament.

**1.3.2. *Breathing in and out air in the environment*:** Modifying your way of living to suit the weather, making sure the air you breathe is pure, and making sure your lungs are functioning at their best.

**1.3.3. *Rest and movement*:** Frequent exercise that fits your personality and lifestyle, together with adequate downtime and relaxation.

**1.3.4. *Sleep and awakening*:** Feeling alert during the day and obtaining the recommended quantity of undisturbed, high-quality sleep.

**1.3.5. *Feelings and emotions*:** Feeling and expressing emotions in a healthy way.

**1.3.6. *Retention and Elimination*:** Effective elimination on a regular basis. While the retention of bodily waste may cause harm in the body.

## 2. Unani evaluation and diagnosis

Through questioning, tongue and pulse examinations, and urine and stool investigations, the disease of the humors is diagnosed. A person's temperament and humors are used to rule out their diagnosis. Additionally, diseases are categorized based on the temperament in which they appear. Unani treatment aims to support the body's inherent healing capacity and balance the four humors. A crucial initial step in resolving a humoral imbalance is addressing lifestyle issues, such as proper meal adoption and selection. Several herbal formulations are used to "ripen" and subsequently "purge" the offending humor if the problem is more severe4.

## 3. India's Historical Foundations and Development

Greek physicians like Hippocrates and Galen are credited for originating unani medicine, which was further developed by Persian and Arab intellectuals like Ibn Sina (Avicenna). Unani, which was brought to India by Arab traders in the eighth century and established during the Mughal era, flourished in a culture that was already deeply rooted in Ayurveda and other native customs[5]. A syncretic medical culture was fostered by Mughal patronage, which resulted in the translation of classical works into Persian and Arabic and the founding of organizations such as the Dawakhana (pharmacy). Hakims or Unani practitioners, were essential to Indian healthcare during the 19th century, providing services to both the aristocracy and the public.

The Indian government now recognizes Unani as one of the official systems under AYUSH, which stands for Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy[6]. Its institutional presence is highlighted by organizations such as the National Institute of Unani Medicine (NIUM)[7] in Bengaluru and the Central Council for Research in Unani

Medicine (CCRUM)[8]. The system is available in both urban and rural areas of India, especially in states like Uttar Pradesh, Delhi, and Hyderabad, and has more than 40 Unani colleges and thousands of registered practitioners.

## 4. Guidelines and Procedures

The foundation of Unani medicine is the idea that a person's temperament and health are determined by their four humors: blood, phlegm, yellow bile, and black bile. An imbalance of these humors causes disease, and the goal of treatment is to bring the body back into balance through nutrition, lifestyle, herbal remedies, and treatments like regimental therapy (Ilaj-bil-Tadbeer), which involves hydrotherapy, massage, and cupping. Unani's diagnostic methods, which include urine analysis and pulse reading, demonstrate a thorough comprehension of the body's signals and are customized for each patient's particular constitution.

The extensive pharmacopeia of the system includes treatments derived from plants, minerals, and animals. Decoctions, powders, and oils are common therapies; they are frequently made with careful regard to traditional formulae like Majoon and Khamira. To address chronic illnesses like diabetes, arthritis, and respiratory ailments, Unani's emphasis on prevention—through dietary and lifestyle changes—resonates with contemporary health trends.

## 5. The Significance of Unani in Contemporary India

Unani provides accessible and reasonably priced healthcare solutions in a nation where access to treatment is still unequal, especially for marginalized people. It is affordable due to its use of locally grown herbs and non-invasive treatments, and its all-encompassing strategy fits in with the growing interest in integrative medicine around the world. For example, Unani remedies for digestive problems, skin conditions, and stress-related illnesses have become more and more popular, frequently assisting allopathic care[9].

Furthermore, Unani foreshadows customized medicine, a new development in contemporary healthcare, with its emphasis on temperament-based treatment. In contrast to mainstream medicine's one-size-fits-all approach, Unani practitioners provide a nuanced viewpoint by customizing therapies to each patient's humoral balance. Additionally, studies backed by CCRUM have confirmed the effectiveness of Unani remedies for ailments like Vitiligo and psoriasis, enhancing its scientific legitimacy.

## 6. Obstacles and the Way Forward

Even with its advantages, Unani still has a lot of problems in India. Compared to Ayurveda or Allopathy, the system is not as well-known and is frequently seen as being less strict or antiquated. Due to differences in practitioner training and quality, standardization of Unani medications and procedures is still a challenge. The integration of Unani into mainstream healthcare is also hampered by a lack of robust clinical trials and insufficient collaboration between hakims and allopathic doctors.

Several actions are required to address these problems. First, more money for research and development can help bolster the body of data supporting Unani treatments, which will help skeptics believe in them. Second, in order to increase Unani's popularity, public health campaigns ought to emphasize its advantages, especially its preventive and holistic features. Third, combining Unani instruction with contemporary medical programs may result in professionals who are knowledgeable about both systems, enabling multidisciplinary treatment. Lastly, quality and scalability may be guaranteed by using India's biodiversity to get Unani herbs sustainably[10]. Some practitioners have even treated COVID-19 in recent years[11], and it has been suggested that this medical approach can also help treat several lifestyle diseases[12].

## 7. An Appeal for Reviving

Unani medicine is a living practice that has the potential to treat current health issues; it is not only a holdover from India's past. Its focus on prevention, balance, and natural solutions is in line with global trends toward patient-centered, sustainable healthcare. India can leverage Unani's assets to enhance its healthcare environment by allocating resources towards research, teaching, and integration.

Unani serves as a reminder of the knowledge ingrained in the country's cultural past as it negotiates the challenges of contemporary medicine. It is time to accept this age-old system as a partner, not a substitute, in creating a more inclusive and healthy future for India's diverse populace. With the use of science and tradition, today's hakims can set the standard for redefining wellness for future generations.

## 8. Conclusion

With its deep roots in India's rich cultural and historical heritage, the Unani medical system has endured as a pillar of holistic care. To treat the body and mind as a harmonious whole, Unani integrates herbal treatments, therapeutic techniques, and lifestyle changes, drawing inspiration from ancient Greek, Persian, and Arab traditions. Unani, which has been practiced for centuries in India, is still a vital component of the country's healthcare system and provides alternatives to traditional medicine, particularly in the treatment of chronic and lifestyle-related illnesses. Unani medicine's tenacity in the face of contemporary difficulties is evidence of its continuing applicability. The Unani system can keep improving people's health and well-being worldwide by accepting scientific research, using contemporary technologies, and raising awareness. It is evident that the age-old practice of Unani healing is a dynamic, developing field with much to offer in the fast-paced, health-conscious world of today rather than merely being a holdover from the past.

The Unani system is positioned to play a crucial role in developing a more comprehensive and balanced approach to healthcare as India works toward the merging of traditional and contemporary medicine. It serves as a reminder that knowledge from the past can greatly influence the direction of medicine in the future.

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# Optimization of Natural Colorant Extraction from the Fruit Peels of Wild Pomegranate

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## Abstract

*Punica granatum* var. daru, commonly referred to as wild pomegranate, is widely distributed across Himalayan region and is characterized by its sour flavoured arils (anardana). A large quantity of fruit peels generates during the anardana production, which are traditionally used for various herbal and tanning purposes. These biowaste peels are a rich in polyphenolics and other bioactive constituents. Despite of its phytochemical richness and traditional values, limited research has focused on the valorisation of its fruit peel waste, especially for natural dye extraction. To validate its traditional claim, present study aimed at the valorisation of underutilized fruit peels of wild pomegranate through protocol optimization for extraction of natural colorant. The influence of three critical parameters including material to liquor Ratio (MLR), pH, and time on the optical density were systematically examined. Additionally, biochemical parameters such as total tannin and flavonoid content were assessed. The optimum extraction conditions were determined to be an MLR of 3 g/100 mL, pH 3, and time of 15 minutes, under which a reddish-brown dye with optical density 1.41 was obtained with the yield of 18.33%. Biochemical parameters including total tannin content (TTC), and total flavonoid content (TFC) were also found 0.28%, and 0.14%, respectively. The extracted dye imparted various shades of yellowish-brown when applied to different textile substrate. This is first time report that highlights a sustainable and eco-friendly approach for the valorisation of such biowaste, with promising implications for its integration into large scale sectors such as textiles, nutraceuticals and pharmaceuticals.

**Keywords:** Optimization, natural dye, bioactive compounds, flavonoids, tannins, wild pomegranate.

## 1. Introduction

Excessive use of synthetic dyes results in significant environmental constraints as well as various health hazards, including carcinogenicity, organ damage, and potentially life-threatening health complications[1]. To overcome these obstacles, it is necessary to find better natural coloring alternatives with sustainable extraction processes for colorant that optimize energy, time, and chemical consumption, providing the colorant with high absorbance and yield[2, 3, 4]. The advantages of natural dye extraction are cost effective, renewable, and non-carcinogenic and have no allergic reaction on skin.

Wild pomegranate (family Punicaeae), also known as daru, dadim, or darmu (Figure 1). It is a deciduous thorny shrub or tree reaching heights of 8 to 10 meters native to Central Asia, Iran, and Turkmenistan to northern India at 900 to 1800 masl[5]. It is widely distributed across mid-hill regions of Himachal Pradesh, Jammu and Kashmir, and Uttarakhand states in India[6]. This variety of pomegranate is distinguished from its cultivars due to its sour flavored arils known as anardana. During the processing of anardana, a large quantity of biowaste fruit peels is generated that remains underutilized. Fruit peels have traditionally been utilized in herbal applications and tanning to obtain yellow, brown, or darker shades due to their coloring properties. They were also used in dyeing leather and preparing ink for writing on takhti by school children[7, 8, 9]. The coloring ability of daru is due to the presence of an abundant quantity of chemical compounds, including phenolics (mostly hydrolyzable tannins, flavonoids, anthocyanins). These metabolites, notable polyphenols, are of particular interest from a nutraceutical perspective because of their antioxidant potential and resultant health advantages such as preventing various ailments, such as inflammation, cancer, diabetes, cardiovascular disease, and neurodegeneration[10].


**Figure 1:** **a**. Shrub, **b**. fruits of *Punica granatum* L. (wild pomegranate)

Despite the presence of bioactive compounds and traditional use of wild pomegranate peels, there is an evident research gap in scientific research focused on developing an efficient and optimized extraction protocol for natural colorant from biowaste fruit peels of daru variety. Moreover, empirical validation of traditional claims regarding their dying properties is limited. Therefore, the present study aims to extract a natural colorant from the peels of wild pomegranate using a classical extraction method, optimizing parameters such as MLR, pH, and extraction time to achieve maximum optical density. Additionally, biochemical parameters, including total tannin and flavonoid contents responsible for coloration, are also evaluated. These underutilized fruit peels can be a potential alternative for synthetic colorant that can be used in various nutraceutical and pharmaceutical industries.

## 2. Materials and Methods

### 2.1 Plant material and Chemicals

The wild pomegranate fruit peels (biowaste) were procured from the Himalayan Forest Research Institute (HFRI), Shimla, sourced from the Kariyali region of Himanchal Pradesh. The peels were thoroughly washed, lyophilized and pulverized into fine powder, which was subsequently stored into airtight containers at -20°C until further analysis. Analytical grade reagents including aluminium trichloride, citric acid, anhydrous sodium carbonate, ferrous chloride, Folin–Ciocalteu reagent, gallic acid, quercetin, potassium sodium tartrate tetrahydrate were obtained from Merck (India).

### 2.2 Extraction of the colorant

Optimization of natural dye extraction method in cultivated pomegranate has been previously reported in Sinha et al.[11], and Lei et al.[12]. In contrast, the present study focused on sustainable extraction of dye from wild grown pomegranate. Based on these previous reported studies, an optimized sustainable protocol was developed and applied for extraction process.

In this method, three independent variables including material to liquid ratio (MLR), pH and extraction time were assessed. Optimization was carried out by varying one parameter at a time while keeping the others constant to determine its effect on the optical density (OD) of the extract. Fruit peel samples (1, 2, 3, 4, 5 and 6 g) were extracted with boiled with 100 g distilled water for a period varied from 15-90 minutes at 15 minutes interval under different pH conditions (3,7 and 9). Citric acid (0.01%), and sodium carbonate ($Na_2CO_3$, 0.01%) were used to adjust the pH. The boiling temperature was maintained at $90^0$ C by simmering the burner after reaching boiling water to avoid complete evaporation. The resulting extracts were filtered using Whatman No. 1 filter paper and stored in amber bottles at 4 °C for further analysis. The optical density of the dye solution was measured at 535 nm using UV-Visible Spectrophotometer. Optical density was calculated using Beer-Lambert law:

$$A=\varepsilon.l.c$$

The yield of the extracted dye was also calculated in percentage (%).

### 2.3 Determination of bioactive constituents

#### 2.3.1 Total tannin content (TTC)

Total tannin content was quantified using Folin–Ciocalteu method with some modifications as described by Lahare et al.[13]. In this method, 1 mL of dye extract was mixed with 5 mL of Folin–Ciocalteu reagent, followed by the addition of 10 mL of sodium carbonate solution. The mixture was incubated for 1.5 hr at room temperature, after which the absorbance was recorded at 740 nm using a UV–Visible spectrophotometer.

#### 2.3.2 Total flavonoid content (TFC)

The total flavonoid content was estimated using aluminium chloride colorimetric method, as previously reported by Lahare et al.[13]. 1 mL of extract was mixed with 4 mL of distilled water and 0.1 mL of 5% $NaNO_2$. After 5 minutes, 0.1 mL of 10% $AlCl_3$ solution was added, followed by 2 mL of 1 M NaOH after another 6 minutes. The final volume was adjusted to 10 mL with distilled water, and the absorbance was measured at 510 nm.

The results were expressed in percentage (%). Standard calibration curve of quercetin and tannin acid are displayed in Figure 2.

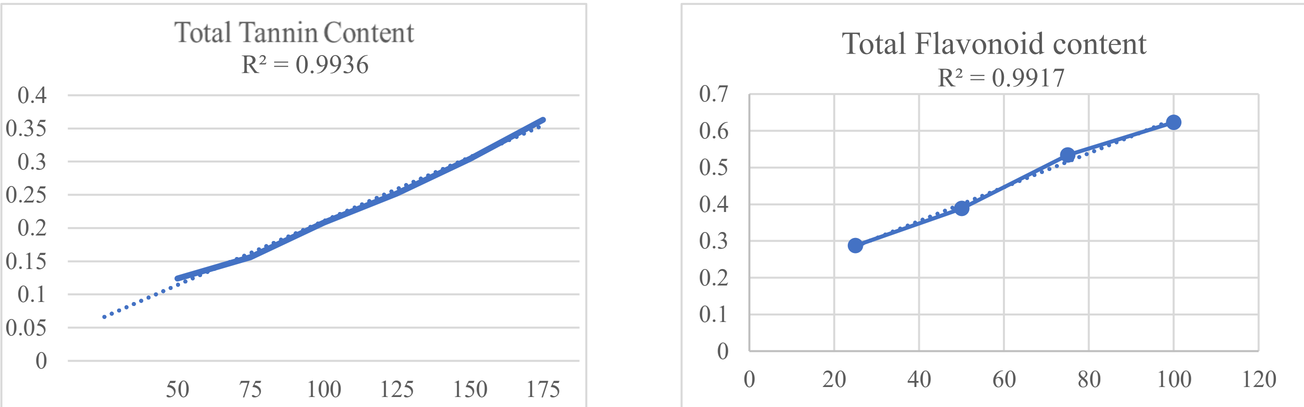


**Figure 2.** Standard Calibration Curve of TTC and TFC of Extracted Colorant

### 3. Results and Discussion

The experimental data generated during optimization for MLR, pH and time is presented in Table 1a and Table 1b, respectively. The optimized natural dye extraction protocol yielded a colorant with enhanced optical density, yield and extraction efficiency compared to previously reported methods. This indicates a significant improvement in both methodology and dye quality, areas that were underexplored in prior studies.

### 3.1 Optimization of Extraction Parameters

A total of two protocols were evaluated namely, Sinha et al.[11], Lei et al.[12] and the optimized method developed in the present study. The previously reported protocols failed to simultaneously achieve both maximized optical density and dye yield. However, the protocol optimized in this study utilized energy efficient and sustainable reagents and solvents to extract a reddish-brown dye with high optical density and yield. The optimal extraction conditions were determined to be MLR of 3 g/100 mL, pH 3 and extraction time of 15 minutes, resulting in the highest recorded optical density of 1.41 and yield of 18.33%. The yield found superior to reported literature 0.64%[11] and 17.4%[12]. The enhanced performance under these optimized conditions may be attributed to both individual effect and synergistic interaction among the three independent variables. A linear increase in MLR may be attributed to an increment in optical density, consistent with previous findings by Tabaraki et al.[14], which suggest enhanced mass transfer kinetics during the process.

In contrast, both pH and time showed a distinct behavior when compared to the trends observed in the MLR model. Initially, the optical density increased with time and decreasing pH, followed by a decline. This can be explained by the pH sensitive nature of natural colorants, high alkalinity often leads to colorant degradation, while extreme acidic conditions may hinder tannin hydrolyzation, both of which results in reduced optical density[15]. This behavior observed in extraction time and pH may be attributed to the attainment of a saturation point, beyond which the diffusion of colorant compounds reaches to equilibrium, resulting in no significant increase in optical density, even when the extraction is continued at a constant temperature of 90 °C and after a time duration of 15 minutes.

Overall, lower MLR and shorter extraction time were chosen, making the optimized method not only energy-efficient but also cost-effective, eco-friendly, and scalable. These attributes make it a promising sustainable alternative for natural dye applications in large scale industries including textiles, nutraceuticals and pharmaceuticals.

**Table 1a. Experimental Data of Optical Density**

**MLR and pH**

| **MLR** | **pH** | | |
|---|---|---|---|
| | **3** | **7** | **9** |
| **1g** | 0.536 | 0.482 | 0.697 |
| **2g** | 0.847 | 0.841 | 1.030 |
| **3g** | 1.410 | 1.291 | 1.266 |
| **4g** | 1.411 | 1.231 | 1.234 |
| **5g** | 1.412 | 1.244 | 1.244 |
| **6g** | 1.413 | 1.211 | 1.290 |

**Table 1b. Extraction Time**

| **Time** | **Optical density** |
|---|---|
| **15** | 0.211 |
| **30** | 0.211 |
| **45** | 0.214 |
| **60** | 0.217 |
| **75** | 0.217 |
| **90** | 0.218 |

## 3.2 Functional performance of Extracted Dye

The qualitative functional performance of the extracted dye was assessed through its application on textile dying. The evaluation parameters included appearance, color strength (K/S) and absorbance. The dying procedure was performed sequentially as mentioned below:

### 3.2.1 Scouring of Fabric

Scouring was performed to remove impurities and enhance dye absorption. Cotton fabric was treated with a solution containing 0.5 g/L Sodium carbonate and 2 g/L nonionic detergent at 50 °C for 25 minutes, maintaining a MLR of 1:50. Post treatment, the fabric was thoroughly rinsed with tap water and air-dried at room temperature. Before dying and mordanting, the scoured fabric was soaked in clean water for 30 minutes prior to ensure uniform dye uptake.

### 3.2.2 Dyeing and mordanting

The natural dye extract (0.5%) was applied to silk, cotton, and wool fabrics using alum as a mordant (Figure 3). Three different mordanting techniques were evaluated through pre-mordanting, post-mordanting and simultaneous mordanting. Simultaneous mordanting resulted in dye precipitation and was therefore not recommended for further use. Conversely, pre- and post-mordanting approaches yielded better outcomes. Among these, post mordanting is highly recommended for textile application with the highest color strength (K/S= 12.68). The dye exhibited excellent affinity for silk and wool, likely due to their high protein content which promotes stronger interaction and enhanced dye fixation, resulting in deep and uniform color shades. Nevertheless, cotton, a cellulose fabric, exhibited comparatively lighter shades, but mordanting significantly improved color adherence. The mordant facilitated effective chelation with the dye molecules, producing intense brownish hues on the fabric.

The promising results indicate that the extracted dye is particularly suitable for proteinaceous fibers, while cellulosic fibers like cotton can also be effectively dyed with the aid of mordants. Further studies should include color fastness evaluation to future optimize dyeing applications and expand shade diversity from this natural colorant.

**Figure 3.** Mordant alum **a.** Wool, **b.** Silk, **c.** Cotton

### 3.3 Chemical constituents of extracted dye

The fruit peels of wild grown pomegranate are known to be rich in various bioactive constituents, particularly poly-phenolics such as tannins, flavonoids, and phenolic acids[10]. These polyphenolics (tannins and flavonoids) are primarily responsible for the color imparting properties of the extracted dye. In this study, TTC and TFC of the dye extract were assessed to evaluate its pigmenting potential. Phytochemical screening confirmed a substantial presence quantity of these color-imparting constituents, suggesting a high coloring potential and strong affinity for textile fibers, especially when used with mordants. Chemical constituents such as ellagic acid, gallic acid, quercetin and kaempferol are known not only for their contribution to the color stability but also for their antioxidant properties, which enhances the functional profile of the dye.

Total tannin and flavonoid content of colorant extracted under the optimized conditions were 0.28% and 0.14%, respectively. These values are consistent with, and in some cases higher than, those reported for cultivated pomegranate variety, such as tannin content of 0.100 ± 2.49%[16] and flavonoid content of 0.57 ± 0.3%[17]. The higher tannin and flavonoid content observed in wild pomegranate peels underscores their phytochemical richness and supports their potential use as a natural source of dye. Moreover, the presence of these bioactive compounds highlights dye's applicability not only in textile coloration but also in bifunctional formulations, including food products, cosmetics, and pharmaceuticals, where natural antioxidant non-toxic pigments are increasingly in demand.

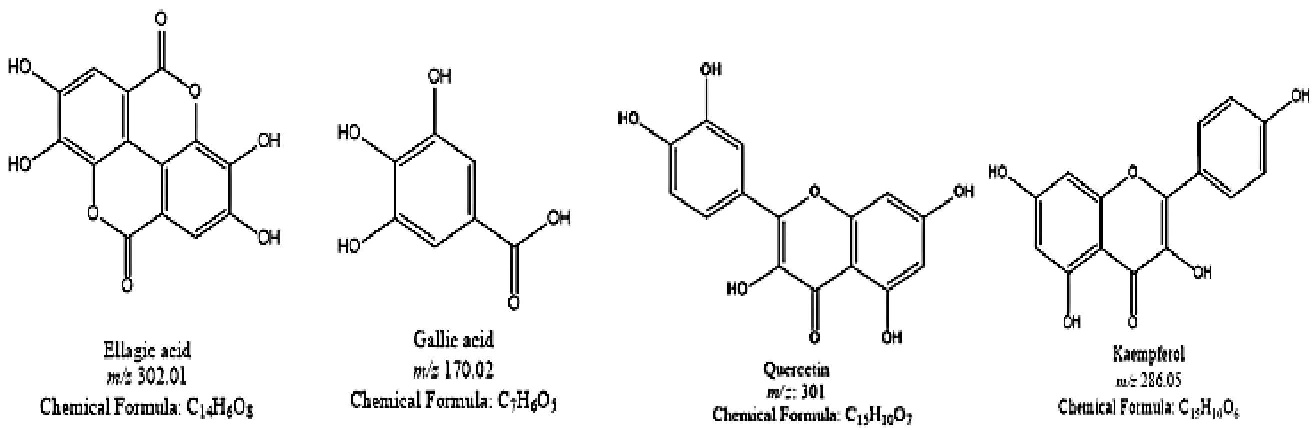


**Figure 4.** Characteristic unit of major color imparting chemical constituents

## 4. Conclusion

This study presents the first report on the extraction of a natural colorant from biowaste fruit peels of wild pomegranate using an eco-friendly, non-toxic and energy-efficient heat-assisted classical method. The extraction process was systematically optimized by evaluating the effects of three independent variables including MLR, pH, and extraction time on dye yield and optical density. The optimized conditions, i.e. MLR of 3 g/100 mL, pH 3, and extraction time of 15 minutes, yielded a reddish-brown dye obtained with elevated optical density (1.41) and an appreciable yield (18.33%). Phytochemical evaluation confirmed the presence of significant levels of TTC (0.28%) and TFC (0.14%), which are key contributors to the dye's coloring properties and antioxidant potential. Textile applications revealed strong dye-fiber affinity, especially in protein-based fabrics such as silk and wool. Post mordanting with alum resulted in improved color strength and uniformity, further supporting the dye's suitability for textile applications. However, optimization using statistical methods can provide more robust and valuable insights. Application of dye with different mordants for textiles (including fastness properties evaluation) and food products can also be explored in the near future. Overall, this study highlights the potential of wild pomegranate peel-derived dye as a natural, sustainable alternative to synthetic colorants with promising applications in textiles, nutraceuticals, and pharmaceuticals.

## Author contributions

**AB**: Investigations, Data curation, Formal analysis, conceptualization, manuscript writing; **VJ**: Sample collection; **YCT**: Supervision and guidance; **VKV**: Funding acquisition, Project administration, Resources, Overall Supervision and guidance, Writing - review & editing.

## Conflict of Interest Statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

## Data Availability

All data generated or analyzed during this study are included in this published article.

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# Impacts of Pulp and Paper Mill Effluent on the Germination and Growth of Gram Seeds

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## Abstract

Different types of agro-based industrial effluents are generated from various sectors and discharged into the different water bodies as well as in soil, and these are seriously harming the biota of those areas. Nowadays, to reduce water consumption for irrigation, treated industrial waste is now commonly used. This study was conducted to evaluate the impacts of pulp and paper mill effluents on the growth of gram seeds. The Petri-plate culture technique was conducted to investigate the effects of pulp and paper mill effluents on gram seeds and the concentration of such effluents were taken in different concentrations i.e., 25.0 %, 50.0 %, 75.0 %, and 100.0 %, as well as one as control (distilled water) was used. Different physical-chemical parameters of paper mill effluent i.e., color, pH, temperature, total dissolved solids, suspended solids, chemical and biological oxygen demands, dissolved oxygen, total hardness, total alkalinity, and oil and grease were evaluated. Growth metrics like seedling growth and germination percentage of gram (*Cicer arietium* L. variety: Pusa 372) seeds were measured on regular basis within 24 hours of interval daily for assessment of growth responses. Results indicated that the positive effect on seeds growth and germination of gram seeds occurred at a lower level of concentration (25 %) of paper mill effluent but at higher concentration of paper mill effluents (75 and100 %) there were negative impacts on seeds growth and germination.

**Keywords:** *Cicer arietinum* L., Wastewater, Pollution, Physico-chemical characteristics, Seed germination.

## 1. Introduction

The sector of pulp and paper mill plays an essential role in the comprehensive developmental activities of any country, and it mainly depends on the lingo-cellulose-based crop residues. In the northern region of India, most of the paper mills use agricultural plant residues for the production of paper and pulp. In the sector of pulp and paper mills, a large amount of water is used for the processing and manufacturing of pulp and paper, resulting in the release of a substantial volume of sewage into different water bodies. According to some estimated data, 273-450 M3 of water is required for the production of per ton of pulp and paper[1], and as a result generating the 300 M3 of effluents[2] which are generally directly released in different water bodies if without any treatment then the biota and biodiversity of that area get badly affected due to the presence of various toxicants and salts in effluent.

For the preparation of paper in the paper industry, a huge amount of water is used in different stages, such as pulping, pulp washing, and wood preparation, bleaching as well as coating processes. Among all the above processes, the pulping process produces a significant volume of wastewater. Such wastewater, having a higher concentration of biological oxygen demand (BOD), decreased dissolved oxygen (DO) concentration, and increased chemical oxygen demand (COD) due to high microbial activities, disturbed the ecological system in different water bodies. Various studies have shown that treated wastewater, when used at lower concentrations, can be beneficial for the development and growth of crops such as peas, mustard, and rice in different soil types. The treated effluent is used in different crops significantly in order to meet every growth parameter at a level of 30% for the rice crop, 40% for the mustard crop, and 50% for the pea crop, probably sufficient for crop growth.

The effluent released from the industries of paper mills are dark brown and have high concentration of physico-chemical parameters, namely, chemical oxygen demands (COD), biological oxygen demand (BOD), and total solids (TS)[3, 4]. It was observed that firstly alkaline nature of extraction is the primary source of different types of contamination (around 90 % of the entire burden of pollutants) from the paper industries[4, 5, 6]. About 664 pulp and paper industries are working in India, of which nearly 632 mills are working as agro-based residue and recycling fiber-based techniques with a 7.6-million-ton production capacity[7]. The Indian pulp and paper sector is mainly dependent on water, consuming 100-250 m3 of freshwater per ton of paper manufacturing[8]. Moreover, it produces the matching sources of wastewater water nearly 75–225 m3 of wastewater per ton of paper is released into the soil and different water bodies[9, 10, 11]. There were 20 different industrial types, such as pulp and paper that fell under the red category due to their potential for environmental pollution[12].

After treatment, the wastewater from paper industries is utilized in irrigation practices for the growth of different crops as organic manure. If the effluent is used without treatment in the irrigation sector, different toxic substances can reduce crop growth and affect the properties of the soil[13, 14]. Different studies have been done for the assessment of the impact of wastewater generated from pulp and paper mills on different types of germination of seeds, crop growth[15], and the amount of chlorophyll in maize plants. It was suggested in previous studies that the highest plant growth was observed at a 25% wastewater concentration and at75% effluent concentration, respectively, which enhanced the concentration of chlorophyll. Impact of paper mill effluent on germination of seed of rice (*Oryza sativa* L.) crops grown in effluent-prone area, percentage of seeds germination and yield of rice crop were comparatively low[16]. A study done by Singh et al.[17] concluded that the impact of wastewater on wheat plants resulted in increased chlorophyll concentration, root and shoot biomass growth, and grain yield in rice plants.

Gram (*Cicer arietinum* L.) commonly known as chickpea seeds were taken as test plants seeds because it is an important leguminous crop grown in India and other parts of the world for its high protein and nutritional value. Gram seeds are mainly used for human as well as animal consumption and animal feed. Gram seeds are rich in protein, dietary fiber, and essential vitamins and minerals. Gram crop plants are also used in crop rotation patterns due to their ability to fix the nitrogen content in soil and help in improving the soil fertility. Gram crop plants are typically sown in 'rabi' (winter) season, and it requires well-drained loamy soil and moderate rainfall.

## 2. Materials and Methods

### Experimental setup:

The Petri-plate culture experiment was conducted in laboratory under controlled conditions of environment to investigate the paper mill effluent effects on the growth and germination of gram seeds. For the proper growth of gram seeds in petri-plate, we used cotton beds. Paper mill wastewater is used at four levels, such as 25.0 %, 50.0 %, 75.0 %, and 100.0 %, with control i.e. distilled water. Seed germination and seedling growth were measured daily basis for the assessment of the seed's growth percentage and seedling growth ratio of gram seeds.

### Collection of effluent and analysis of physico-chemical parameters:

The sample of pulp and paper mill effluent was collected from outlet of Yash paper mill, Ayodhya

(Faizabad), U.P., India. The samples were collected from an outlet in paper mill industrial area in the clean, sterilized plastic container and stored at 4° C for further analysis, as prescribed by APHA[18]. For the assessment of physico-chemical characteristics, such as pH, temperature, total solids, total dissolved solids, total suspended solids, chemical oxygen demand, biochemical oxygen demand, dissolved oxygen, total hardness, total alkalinity, and oil and grease, the use of standard methods prescribed by APHA[18] were followed. The different concentration of pulps and paper mill effluents, i.e., 25.0 %, 50.0 %, 75.0 %, and 100.0 % were prepared by addition of distilled water in the appropriate volume along with a control or blank was prepared by using the distilled water only in petri-plate experiment. The glass petri-plates were pre-sterilized and for seed germination sterilized cotton was used for making seed bed in petri-plate bottom and each petri-plate was marked and covered by its own lid.

## Collection of seeds:

Commercially available gram (*Cicer arietinum* L. variety- Pusa: 372) seeds were procured from local market, used for the experiments. Gram seeds of uniform size, color and weight were collected for the best results in our experiments.

## Initial growth analysis:

The selected gram seeds were sowed in petri-plate experiment showing the result after 24 hours in petri-plate. We analyzed the viable seed germination on a daily basis and measured the seed growth on also daily basis. We run this experiment for 120 hours from the sowing time and analyze the findings obtained from this experiment.

## Germination percentage:

The number of seeds germinated in each treatment was observed on daily basis from the sowing time. The total germination percentage was calculated by using the following formula:

$$Germination\ percentage = \frac{Total\ number\ of\ seeds\ germinated}{Total\ number\ of\ seeds\ sown} X100$$

**Table 1:** Results of physico-chemical parameters analysis of pulp and paper mill effluent:

| Physico-chemical parameter | Effluent results | Standard |
|---|---|---|
| Temperature (°C) | 32° C | 40°C |
| pH | 7.6 | 6.5-8.5 |
| DO (mg/L) | 2.9±0.8 | 5-6 |
| BOD (mg/L) | 88.75±.95 | 30 |
| COD(mg/L) | 560±8.73 | 250 |
| Alkalinity (mg/L) | 412.88±5.37 | 600 |
| Hardness (mg/L) | 644±5.10 | 600 |
| TDS (mg/L) | 168.9±2.98 | 2000 |
| TSS (mg/L) | 39.54±1.48 | 100 |
| Oil and grease (mg/L) | Nil | 10 |

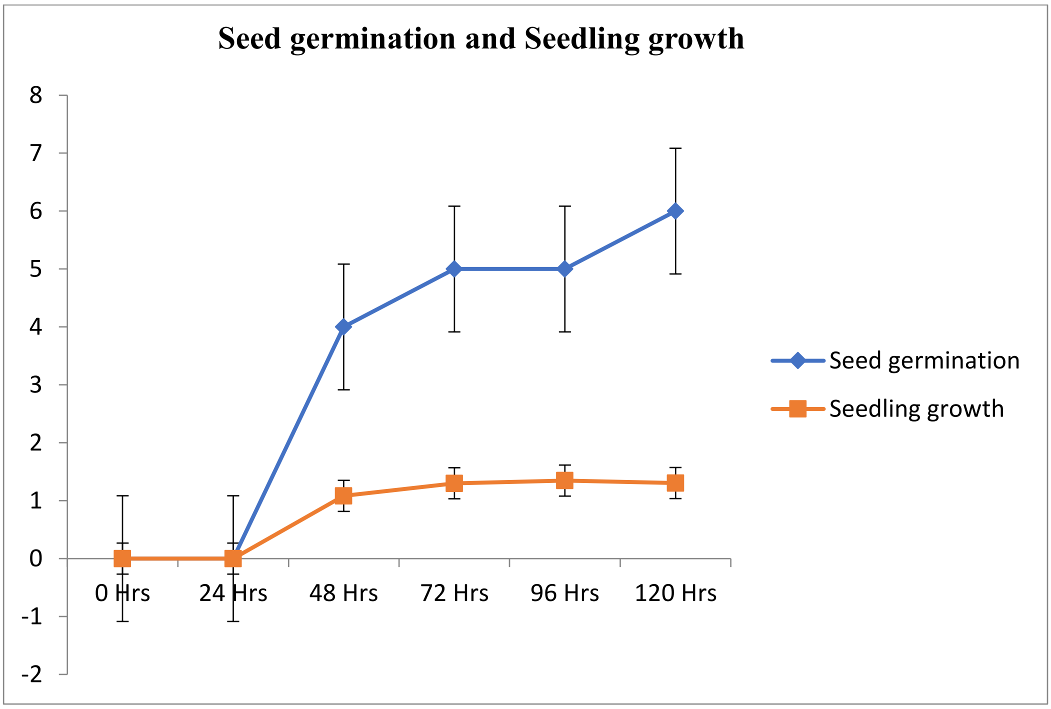
**Table 2:** Seed Germination percentage of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds on different concentrations of paper mill effluent after 24 hours and up to 120 hours of sowing.

| Time interval | Blank | 25 % | 50 % | 75 % | 100 % |
|---|---|---|---|---|---|
| **O hour** | 0 | 0 | 0 | 0 | 0 |
| **After 24 hours** | 0/6 | 1/6 (16.66%) | 1/6 (16.66%) | 2/6 (33.33%) | 1/6 (16.66%) |
| **After 48 hours** | 4/6 (66.66%) | 4/6 (66.66%) | 3/6 (50%) | 4/6 (66.66%) | 3/6 (50%) |
| **After 72 hours** | 5/6 (83.33%) | 4/6 (66.66%) | 5/6 (83.33%) | 4/6 (66.66%) | 4/6 (66.66%) |
| **After 96 hours** | 5/6 (83.33%) | 4/6 (66.66%) | 5/6 (83.33%) | 4/6 (66.66%) | 4/6 (66.66%) |
| **After 120 hours** | 6/6 (100%) | 5/6 (83.33%) | 5/6 (83.33%) | 5/6 (83.33%) | 5/6 (83.33%) |

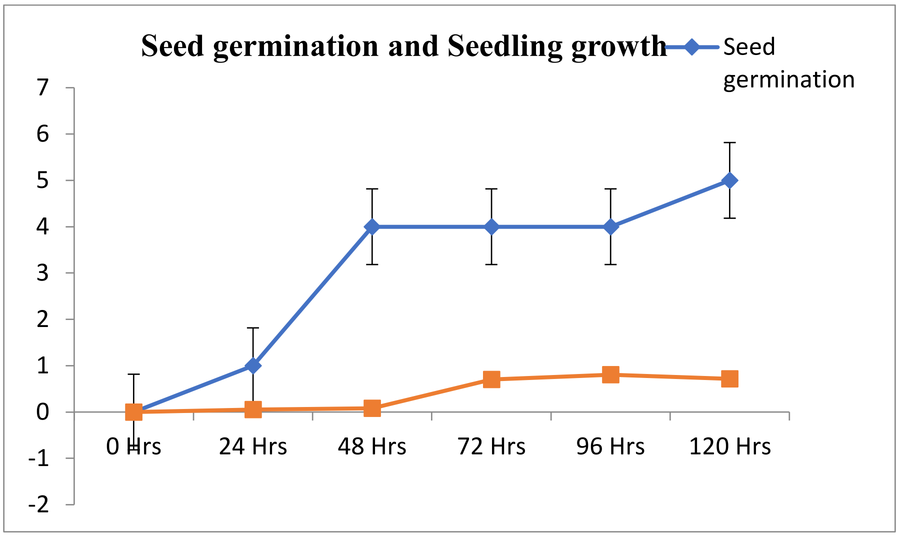
**Table 3:** Growth of seedlings of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds in cm, soaked in different concentrations of paper mill effluent after 24 hours and up to 120 hours of sowing.

| Time interval | Blank/ 0% effluent and seedling growth (cm) | 25 % effluent and seedling growth (cm) | 50 % effluent and seedling growth (cm) | 75 % effluent and seedling growth (cm) | 100 % effluent and seedling growth (cm) |
|---|---|---|---|---|---|
| *0 hour | 0 | 0 | 0 | 0 | 0 |
| After 24 hours | 0 | 0.055 | 0.050 | 0.060 | 0.005 |
| After 48 hours | 1.083 | 0.083 | 0.513 | 0.833 | 0.672 |
| After 72 hours | 1.301 | 0.703 | 0.854 | 0.971 | 0.75 |
| After 96 hours | 1.347 | 0.805 | 1.136 | 1.16 | 0.885 |
| After 120 hours | 1.305 | 0.916 | 2.9 | 4.1 | 2.133 |

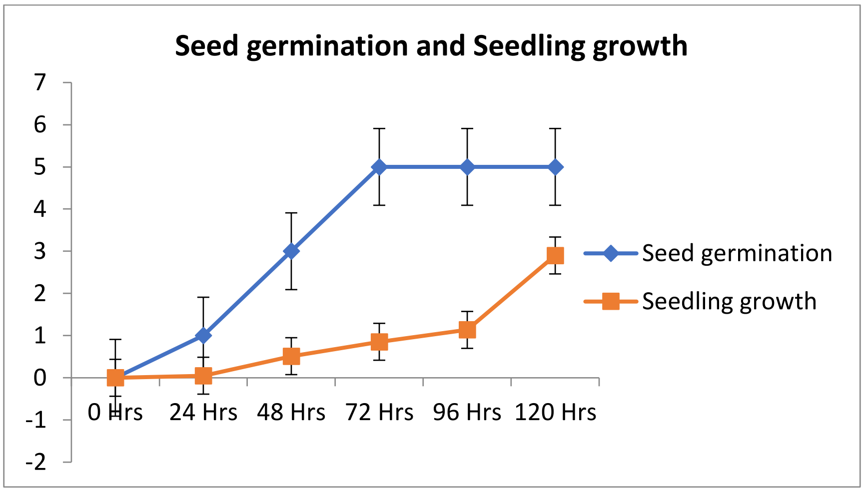
(*The comparison time (starting at 0 Hour) and the seedling growth in cm is almost the 0 (Zero) has been reported to be almost '0' in others too, hence the comparative statistical analysis with Control to other hours valued '0' with no specific statistical data with ANOVA was found.)



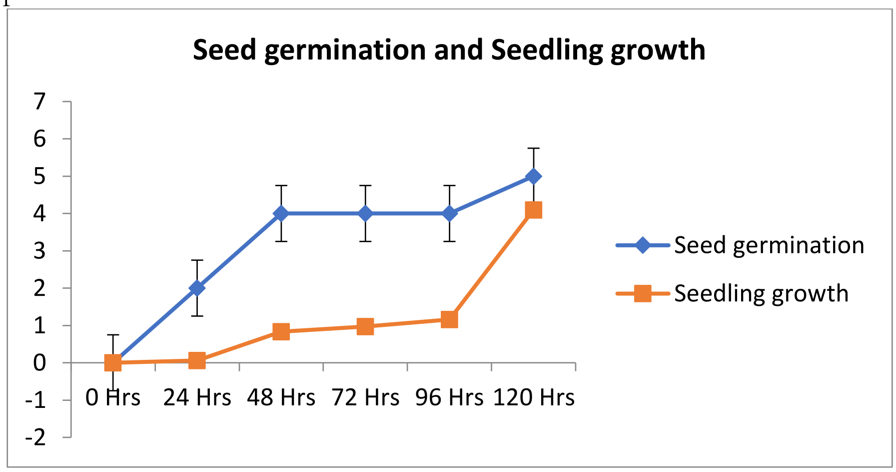

**Graph 1:** The graph shows the seedling growth and seed germination of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds in Control or Blank (Only distilled water)



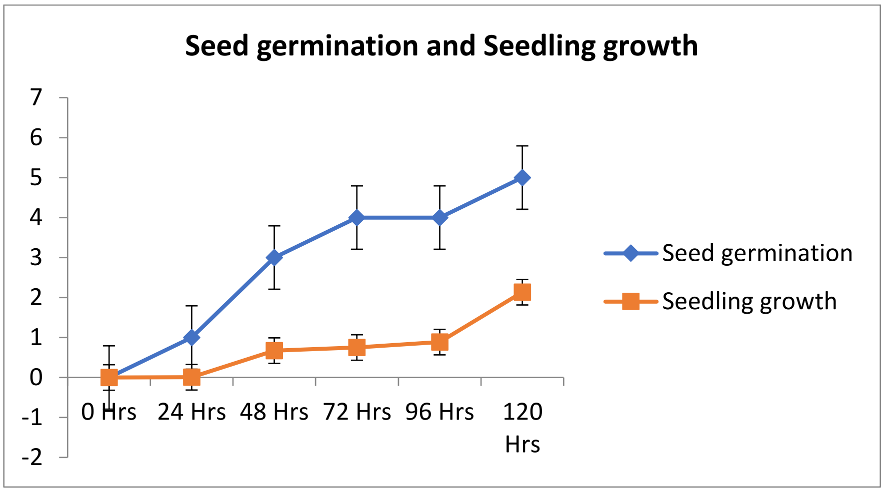

**Graph- 2:** The graph shows the value of seedling growth and seed germination of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds at 25.0 % of pulp and paper mill effluent.




**Graph- 3:** The following graph shows the value of seedling growth and seed germination of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds at 50.0 % of pulp and paper mill effluent.




**Graph 4:** The following graph shows the value of seedling growth and seed germination of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds at 75.0 % of pulp and paper mill effluent.




**Graph- 5:** The following graph shows the value of seedling growth and seed germination of Gram (*Cicer arietinum* L. variety- Pusa: 372) seeds at 100.0 % of pulp and paper mill effluent.

### Seed germination:

For the assessment of seed germination, pre-sterilized glass petri-plates were prepared independently under regulated circumstances in the laboratory, and the experiment was run in triplicate. The petri-plates were kept with sterilized cotton bedding, supplied with paper mill effluent in the concentration of 25.0%, 50.0 %, 75.0 %, and 100.0 % for the experimental setup and use of distilled water as a control or blank. About 10 Gram or 06 seeds were put in each petri-plate following the seed coat rupture. After 24 hours of intervals, the proportions of seeds that germinated and survived were recorded.

### Seedling growth:

After the start of seed germination, the growth of seedlings of gram including plumule (embryonic shoot) and radical (embryonic root) length was measured at intervals of 24 hours. Root and shoot length were measured using a metric scale in 'Centi meter' (CM) to determine various time intervals and the effects of pollutant concentration in different percentage found in paper mill effluent.

## Results

### Physico-chemical analysis:

The analysis of paper mill effluent showed slightly basic pH of 7.6. The effluent of the paper mill showed- Dissolved Oxygen (2.9 mg/L), Biological Oxygen Demand (88.75 mg/L), Total hardness (644.0 mg/L), alkalinity (412.88 mg/L), Total dissolved solids (168.9 mg/L), and traces of oil and grease. In the presence of higher oxygen-demanding chemicals, the concentration of Chemical Oxygen Demand was 560.0 mg/L.

### The impact on seedling growth and seed germination was significant:

The initial period of gram seeds (*Cicer arietinum* L. variety- Pusa: 372) on the growth of different concentrations of wastewater effluent generated from the paper mill i.e., 25.0 %, 50.0 %, 75.0 %, and 100.0 % along with one as control. The present study, showed that the effect of different concentrations of effluent 25.0 %, 50.0 %, 75.0 %, and 100.0 % significantly (0< 0.01) impacted emergence time in comparison to the control.

When the effluent concentration was decreased, then the germination percentage was increased. The highest seed germination of gram seeds (*Cicer arietinum* L. variety- Pusa: 372) was observed at 25.0 % of the wastewater. This type of germination pattern is probably caused by the paper mill toxicant effluents were in diluted concentration with some organic material which can encourage germination. While excess concentrations were entirely preventing or severely suppressing seed germination, because different forms of toxic salts and other toxicants are typically most harmful to the normal growth and development of young plants, but not always at the time of seed germination. The rate of seed germination was slow due to the availability of different toxic substances in the paper mill effluent. Another significant factor preventing seed germination is salinity[19, 20]. Proper hydration of seeds is crucial for controlling metabolism, as well as for seedling growth and seed germination.

**Germination and seedling growth rate at different times:**

**After 24 hours:**

After 24 hours of seeds germination, at different concentrations like; blank (Only distilled water), and 25.0 %, 50.0 %, 75.0 %, 100.0 %of paper mill effluent, showed different phases. In the blank (Only distilled water) after 24 hours, the seed germination was 0/6, and seedling growth was also nil. In 25.0 % of the effluent solution germination percent was 1/6, and seedling growth was 0.055 cm. In 50.0 % of the effluent solution, seed germination was 1/6, and the seedling growth was 0.050 cm. In the solution of 75.0 % of effluent, seed germination was 2/6 and average seedling growth was 0.06 cm, and in 100.0 % of effluent solution, germination was 1/6 and seedling growth was 0.005 cm.

**After 48 hours:**

After 48 hours of treatment, gram seed germination of the blank was 4/6, and average seedling growth was 1.08 cm; in 25.0 % of the effluent sample, the seed germination was 4/6, and average seedling growth was 0.083 cm; in 50% of the effluent concentration, seed germination was 3/6 and average seedling growth was 0.513 cm. In the solution of 75% of the effluent, seed germination was 4/6 and average seedling growth was 0.833 cm; in 100% of the effluent solution, seed germination was 3/6 and average seedling growth was 0.672 cm.

**After 72 hours:**

At the time of 72 hours, seed germination of the blank solution was 5/6, and seedling growth was 1.301 cm; in 25% of the effluent solution, seed germination was 4/6, and seedling growth was 7.03 cm. In the 50% of effluent solution, seed germination rate was 5/6 and seedling growth was 0.854 cm; in 75% of effluent solution, seed germination was 4/6 and seedling growth was 0.971 cm; and in 100% of effluent solution, seed germination was 4/6 and seedling growth was 7.03 cm.

**After 96 hours**:

Seed germination and seedling growth of gram seeds after 96 hours in blank solution were 5/6 and 1.34 cm, respectively. In the 25% effluent solution, the seed germination was 4/6, and seedling growth was 0.805 cm. In the solution of 50% effluent concentration, seed germination was 5/6 and seedling growth was 1.136 cm; in the 75% effluent solution, seed germination was 4/6 and seedling growth was 1.16 cm; and in the 100% effluent solution, seed germination was 4/6 and seedling growth was 0.885 cm.

**After 120 hours:**

Seedling stage parameters such as root length and shoot length of the gram seed after 120 hours were recorded. Seed germination in the blank solution was 6/6, and seedling growth was 1.305 cm. In the 25% effluent solution, seed germination was 5/6, and seedling was 2.9 cm. In 75% of the solution, seed germination was 5/6, and seedling growth was 4.1 cm. And in the 100% effluent sample, the seed germination ratio was 5/6, and the seedling growth rate was 2.133 cm.

## Discussions

The rate of seed germination was slow due the presence of different high rate of toxic substances in the paper mill effluent. Another significant factor preventing seed germination is salinity[19, 20] . Proper hydration of seeds is crucial for controlling metabolism, as well as for seedling growth and seed germination. Pulp and paper mill effluents have harmful pollutants and can even not used as organic fertilizers in fields due to presence of some toxic substances[21]. In their study, Medhi et al.[22] examined the effects of wastewater from pulp and paper mills on the germination and seedling growth of rice, peas, and mustard. They found that lower concentrations of effluent promoted better growth compared to the control group. In a study, Reddy and Borse[23] investigated the impact of effluent on the germination and seedling growth of *Trigonella foenum-graecum*. They found that these parameters decreased when the concentration exceeded 25%, while both germination and seedling growth improved up to that concentration. Kamlesh and Kidwai[24] studied the effects of sugar mill effluent on two fenugreek cultivars, Kasuri and Pusa Bold. Their findings indicated that lower dilutions benefited the initial growth of both plant varieties, whereas higher concentrations of effluent negatively impacted the initial growth parameters. Same results have been reported by us in gram seeds (*Cicer arietinum* L. variety- Pusa: 372) on the growth of different concentrations of wastewater effluent generated from the paper mill situated in Ayodhya (U.P.).

## Conclusion

Pulp and paper mills are an important sector in industries and these mills produce a distinct variety of paper for different uses. Paper mill effluent was analyzed for physico-chemical characteristics, and the results showed that the light brown colour effluent is alkaline in pH, the total hardness, biological oxygen demand, chemical oxygen demand from the treated effluent are also higher in concentrations as compared with Indian standards for water, and dissolve oxygen concentration was also lower. The result of this experiment demonstrated that the retardation of seedling growth and seed germination of gram occurred at high level of toxicants present in high concentration of paper and pulp mill effluent. This study suggested that the treated wastewater has a high concentration of physico-chemical parameters, and other waste is not good for soil health or the production of crops. The normal growth of gram seeds and seedlings is impacted from paper mill effluent. The ratio of germination of seeds demonstrates the sensitivity of seeds in the early phases of development, and the availability of trace metals above the permissible limit in the effluent is a severe concern for the pollution of groundwater and other water resources too. It can be concluded that treated pulp and paper mill effluent should be used in agricultural practices like irrigation purpose instead of directly pouring or mixing into river, canal, other fresh water resources and soil, so that the ground water dependency could be solved and conservation of water should be done for future scenario but the without treated water shouldn't be directly used for irrigation and not to mix with other fresh water resources for other use because it has toxic metallic/nonmetallic elements which could damage environment and further human health.

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## Author's Contribution

RVand SV conducted the experiment and wrote the original draft of the paper. AKS conceptualized and supervised the project, while PK handled the editing and corrections and helped in writing original draft. Additionally, RV, SV, and PK were involved in the various investigation of the study. All authors have read and agreed to the final version of the manuscript.

## Data Availability

All data generated included in this article.

## Conflicts of interest

The authors declare that there is no conflict of interest

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# Ethnobotanical Comparison of *Ocimum sanctum* L. and *Croton bonplandianus* Baill.: Insights into their Traditional and Medicinal Uses

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## Abstract
*Ocimum sanctum* L. also referred to as Tulsi, and *Croton bonplandianus* Baill., commonly referred to as Ban Tulsi or Jungle Tulsi, are two powerful medicinal herbs deeply rooted in traditional medicine, especially within the Indian subcontinent. This comprehensive review delves into the ethnobotanical properties and pharmacological activities of these remarkable plants. Tulsi, often hailed as the "Queen of Herbs," has long been revered for its versatile therapeutic characteristics. It is traditionally utilized to address a wide array of health issues, including chronic fever, dysentery, haemorrhage, vomiting, eye disorders, respiratory infections, diabetes, and gastric and hepatic disorders. Furthermore, Tulsi exhibits antifertility, anti-inflammatory, radiation protection, antibacterial, antioxidant, anticancer, as well as antifungal characteristics, making it a truly multifaceted medicinal herb. On the other hand, Jungle Tulsi is sought after for its efficacy in treating skin diseases, hypertension, wounds, diabetes, cancer, constipation, abdominal dropsy, and various infectious disorders. Like Tulsi, Jungle Tulsi also showcases a broad variety of pharmacological activities, that includes antifungal, hepatoprotective, wound healing, antimicrobial, antioxidant, and anti-inflammatory properties. Given pressing challenge of multidrug-resistant microbial strains, the exploration of novel plant-based antimicrobial agents is more crucial than ever. Tulsi and Jungle Tulsi emerge as promising sources due to their broad-spectrum pharmacological activities. However, further research, including clinical trials and mechanistic studies, is essential to fully unravel the therapeutic potential of these herbs and to develop standardized, safe, and effective herbal formulations.
**Keywords:** Ethnobotany, Pharmacology, Euphorbiaceae, Lamiaceae, Traditional Medicine.

## 1. Introduction
Throughout history, plants have been a primary source of human medicine as well as sustenance. Approximately 4 billion individuals, or 80% of the population of the world, already utilize herbal remedies as a component of their daily medical regimen[1]. Various cultures use locally grown plants to cure common ailments, and these herbal medicines have proven to be remarkably effective over centuries[2]. Certain natural remedies have been shown to work better than traditional allopathic medications. Herbal medicine is the practice of treating human and, occasionally, animal illnesses by using medicinal herbs in different forms, such as extracts, decoctions, or powders. Many people are turning to traditional treatment practices that use the therapeutic properties of herbal medicines for relief due to the drawbacks and adverse effects of some allopathic medications[3].
Holy basil, also referred to as Tulsi in Hindi and Sanskrit, has been a prominent member of the family Lamiaceae and is identified scientifically as *Ocimum sanctum* L. The therapeutic qualities of tulsi have been utilized in Ayurvedic medicine for over 3,000 years to treat a range of illnesses.

Tulsi leaf extracts have been used to cure fever, bronchitis, and other ailments, according to Indian medical books. This extensively grown plant is regarded as a vital household plant in India and has been very prestigious in Hinduism. Hindu mythology goes into great lengths to examine the importance, uses, and traits of tulsi[4]. Tulsi is an aromatic shrub that grows to a height of 3 to 5 feet and is often grown in gardens. Its strong flavor and aroma make it extremely valuable to humans. Traditional Ayurvedic medicine often uses Tulsi leaves to cure a range of illnesses, for example, intestinal disorders, common colds, heart problems, headaches, stomach problems, kidney stones, and more. It is especially effective at treating fevers and has been shown to prevent mosquito reproduction and treat intestinal diseases. The adaptable Tulsi plant has many uses, and its leaves are regularly used for their health-restoring qualities and as a sensory stimulant, greatly improving memory acuity[5]. Tulsi is also known to help with respiratory conditions. An excellent remedy for influenza, asthma, as well as bronchitis is a concoction of Tulsi leaves, ginger, and honey. Owing to its many medicinal benefits, tulsi is regarded as a crucial element for improving well-being. Extensive research and empirical investigations have demonstrated the safety of consuming tulsi in a variety of forms, indicating that this small herb is a considerable source of medical benefits. These therapeutic qualities are acknowledged and supported by recent scientific research. The herb tulsi provides protection against a number of health hazards, particularly those brought on by contemporary lifestyle choices. It is considered the best herb in India and is essential to many Ayurvedic treatments due to its both curative and preventative qualities[3].

The most common species in the *Croton* genus, *Croton bonplandianus* (Euphorbiaceae), goes by a few names. Northern Argentina, Paraguay, and Southern Bolivia are the native habitats of *C. bonplandianus*. It has been frequently referred to as Ban Tulsi (jungle tulsi) because of the way its leaves along with flower cymes resemble those of Tulasi (*Ocimum sanctum*). The plant can be found growing in yards, wastelands, riverbanks, and along roadsides. As a tiny annual herb, *C. bonplandianus* can grow up to 24 inches wide as well as 28 inches tall. The lanceolate leaves, which are 3-5 cm long and alternately arranged, have serrated edges[6]. Because of inadequate light exposure, *C. bonplandianus 's* leaves are coriaceous, smaller, and less pigmented; in contrast, they display more vivid coloration in bright light. The greenish fruits have verrucose surfaces and are oblong capsules, 5 mm in length. The tiny, peach-colored flowers have 12 racemes and tiny, globose flower buds that are placed in upright spikes. They also have five petals, five sepals, and a large number of long stamens that protrude. From September through November, *C. bonplandianus* is in blossom[7]. Traditional medicine has made considerable use of the plant *Croton bonplandianus* L. to treat a diversity of illnesses, encompassing jaundice, infectious diseases, abdominal dropsy, acute constipation, hypercholesterolemia, external wounds, hypertension, and dysentery. Several in vitro & in vivo research have confirmed, *C. bonplandianus* is a crucial source of traditional medicine for treating a variety of illnesses[8].

The current investigation intends to elucidate ethnobotany as well as pharmacology of *O. sanctum* and *C. bonplandianus* to identify research gaps and delineate areas requiring further investigation.

## 2. Methodology

The pharmacological, phytochemical, and ethnomedicinal applications of *O. sanctum* and *C. bonplandianus* were reviewed. The pertinent information was gathered from online resources such as Google Scholar, Web Science, PubMed, Research4Life, Springer, and Science Direct using keywords like *O. sanctum*, *C. bonplandianus* and its synonyms, ethnomedicinal usage, phytochemicals, and pharmacological properties. The title, abstract, and entire study were reviewed to filter the information that was gathered. An agreement between the authors allowed the information to be included. This review does not include personal communications, unpublished results, or extraneous information. This review contains 55 references, with most of the research publications coming from India.

## 3. Historical perspective

*Ocimum* species, such as basils, are commonly referred to be "king of the herbs." The common term "basil" probably originates from Greek words "basileus" and "basilikon," which both mean "king" and "royal." The Rig Veda, a classic Indian text, was the first to reference *O. sanctum*, which was initially used around 1500 BC. In accordance with Ayurvedic tradition, *Ocimum sanctum* has been tonic for many features of life and may assist with a lot of modern health problems. Likewise, *O. sanctum* also referred to as

"Thulasi" or else "Thulasi Ilai," has been greatly valued for its therapeutic properties in the Siddha school of medicine[9]. As an adaptogen, it supports the body's response to stress and has antibacterial, antioxidant, and immunomodulatory properties. The plant, known as "kaphrao" or "bai kraprow," has been utilized as an offering in Buddhist ceremonies and has spiritual, cultural, and historic importance in Thai culture. Additionally, it is offered at temples or incorporated into rituals performed at home. Then, in the Unani medical system, it is called "Tukhm Rehan," and it is known to have antibacterial qualities, ease respiratory discomforts, and support digestive health[10]. Additionally, traditional Chinese medicine uses it to treat digestive system issues like diarrhea and stomach aches as well as infections. *O. sanctum* has been utilized in conventional African medicine for treating whooping cough as well as various fevers. Its leaf decoction has been also utilized to treat coughs in West Africa[11]. For perhaps 5,000 years, tulsi has been considered one of India's most fabled therapeutic herbs. Millions of people use and revere Tulsi's generous healing nature every day for everything from acute critical imbalances to general well-being. In Sanskrit, tulsi signifies "one that is incomparable"-one that does not accept or allow for similarity. The English pronunciation is "tool-see." The Charak Samhita, the earliest ancient Sanskrit Ayurvedic text, which was composed in 400 CE as well as maybe as early as 6000 BC, refers to the lengthy history of Tulsi's medicinal applications. The Rigveda, commonly known as the Book of Eternal Knowledge, which is thought to have been written around 5000 BC, also refers to Tulsi. The entire value of *O. sanctum* is demonstrated by its journey through various texts and medicinal techniques. Consequently, the fact that it has been used in many cultures and medical systems shows its worldwide appeal[12].

In the 18th century, Carl Linnaeus was the first to describe the genus *Croton*. Numerous *Croton* species, including *C. bonplandianus*, have been classified and better understood over time thanks to the efforts of botanists like George Don and others. With reference to its natural habitats in areas like Central and South America, the plant has been positioned within the larger framework of tropical flora. *Croton* species have long been used medicinally by indigenous peoples to cure a variety of conditions, such as digestive and skin disorders. Like other *Croton* species, *C. bonplandianus* might have had traditional medical applications. Interest in the *Croton* genus increased over the 19th and 20th centuries as botanical exploration increased. The species' distinctive qualities were investigated by botanists and horticulturists, who helped to popularise its cultivation in attractive gardening. Because of its colourful leaves and capacity to flourish in tropical and subtropical climes, *C. bonplandianus* became a popular ornamental plant in the late 20th century. Gardeners valued its versatility and little maintenance. The taxonomic classification, traditional use, and horticultural role of *C. bonplandianus* are all part of its historical development. Its development reflects more general plant science concerns, such as ecology, conservation, and the value of traditional knowledge[13].

## 4. Distribution of *O. sanctum* and *C. bonplandianus*

All six inhabited continents have tropical and warm temperate regions where *O. sanctum* is endemic, with Africa hosting the largest number of species. It is also widely distributed in West Africa, Malaysia, Australia, and a few Arab nations. It has recently been proposed that this species originated in North-Central India based on extensive phytogeographical research using chloroplast genome sequences. This therapeutic herb is grown all over India, from the Andaman and Nicobar Islands to the Himalayas, which are near about 1800 meters above sea level. Both as an escaped weed and as a cultivated plant, it is widely distributed. It has been cultivated for its essential oil along with for religious and therapeutic purposes[14].

The native range of *C. bonplandianus* extends from Uruguay to South Bolivia. It grows mostly in the seasonally dry tropical biome and is classified as a shrub or subshrub. It is indigenous to Brazil South, Bolivia, Paraguay, Uruguay, Brazil West-Central, and Argentina Northeast and Northwest. India, Borneo, Bangladesh, Comoros, Gulf States, Cambodia, Laos, East Himalaya, Maryland, Kenya, Malaya, Myanmar, Nepal, Pakistan, Mauritius, Reunion, Nicobar Island, Sri Lanka, Taiwan, Thailand, Rodrigues, Sulawesi, and West Himalayas are among the countries where it has been introduced[15]. It typically grows as a weed along riverbanks, roadsides, and wastelands. It draws a lot of insects and pollinators and has a highly healthy population. It provides ecological functions and is a significant host plant for jewel bugs[16].


A


B

**Figure 1.** Pictures showing A. *Croton bonplandianum* B. *Ocimum sanctum* growing in wild

## 5. Phytochemistry

Tulsi's chemical composition has been quite complicated as well as containing a variety of nutrients along with additional physiologically active compounds, levels of which can vary greatly among strains as well as even among plants in similar regions. Moreover, the amount of several of these components has been greatly impacted through various harvesting, processing, growing, as well as storage circumstances, many of which have been currently unknown. As utilized historically, the herb's pharmacological and nutritional properties are derived from the synergistic interactions among numerous active phytochemicals. Consequently, individual components or else extracts cannot completely replicate Tulsi's effects. Tulsi's intrinsic botanical and biochemical complexity has prevented modern science from standardizing it up to this point[3].

The genus *Croton* has a wide variety of biomolecules. The genus' secondary metabolites are primarily composed of diterpenoids, which may include the skeletal categories such as cembranoid, clerodane, neo clerodane, Hali mane, kaurane, secokaurane, labdane, phorbol, and trachylobane. It has been found that several *Croton* species contain pentacyclic or steroidal terpenoids. Volatile oils comprising mono- and sesquiterpenes, as well as compounds derived from shikimate, are prevalent in the species. The genus' importance from a medical perspective is greatly increased by reports that some species are suppliers of many alkaloids. Numerous studies have focused on phenolic chemicals, primarily flavonoids, lignoids, and proanthocyanidins. Because they contain proanthocyanidins and/or alkaloids, certain *Croton* species exhibit crimson sap[17].

**Table 1: Selected compounds identified from various parts of *O. sanctum* (OS)[3] and *C. bioplandianum* (CB)[17] and their classes.**

| Class | Compund names in OS | Distribution in OS Plant | Functions | Compound names in CB | Distribution in CB plant | Functions |
|---|---|---|---|---|---|---|
| Terpenoids | Urosolic acid | Leaves | Antioxidant | Clerodanes | Leaves | Anti-inflammatory |
| | Carvacrol | Leaves | Neuroprotective | Cembranoids | Leaves | Anticancer |
| | Linalool | Leaves | Antimicrobial | Urosolic acid | Root | Antioxidant |
| | Limatrol | Leaves | Anti-inflammatory | Kauranes | Leaves | Antiparasitic |
| | Methyl carvicol | Leaves | Antimicrobial | Taraxerol | Stem and Leaves | Cardioprotective |
| | Bornyl acetate | Stem | Hypotensive effect | Phorbol esters | Leaves | Antiallergic |
| | β-elemene | Stem | Anticancer effect | Trachylobanes | Leaves | Antitumor |
| | Neral | Leaves | Antineoplastic | Sarcopetalanes | Stem | Muscle contraction |
| | | | | Sonderianin | Leaves | Anxiolytic |
| | | | | Oleonolic acid | Root | Antiasthma tic |
| | | | | Vomifoliol | Stem and Leaves | Immunosuppressive |
| Phenols | Rosmarinic acid | Stem | Antioxidant | | | |
| | Cirsimaritin | Stem | Antiproliferative | | | |
| Flavanoids | Orientin | Leaves | Heart protection | Catechin | Leaves | Antioxidant |
| | Vicenin | Leaves | Antitumor | Gallocatechin | Leaves | Antiviral |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Luteolin | Leaves | Renoprotection | Rutin | Leaves | Anticancer |
| | Apigenin | Leaves | Antiamyloidogenic | | | |
| | Apigenin-7-o-glucuronide | Leaves | Anticomplement | | | |
| | Luteolin-7-o-glucuronide | Leaves | Antidepressant | | | |
| | Molludistin | Leaves | Antibacterial | | | |
| | Isothymonin | Stem | Antifungal | | | |
| | Isothymusin | Stem | Antioxidant | | | |
| | Cirsilineol | Stem | Antithrombotic | | | |
| Alkaloids | | | | Crotsparinine | Leaves | Antioxidant |
| | | | | Crotsparine | Leaves | Antimicrobial |
| | | | | Crotoflorine | Leaves | Antimalarial |
| | | | | Sparsiflorine | Leaves | Antibacterial |
| | | | | Proporphine | Leaves | Antioxidant |
| | | | | Isoquinoline ionone | Leaves | Antifungal |
| | | | | Glaziovine | Stem and Leaves | Antiulcer |
| Essential oil | Eugenol | | Analgesic | | | |
| | Euginal | | Food preservative | | | |
| | Caryophyllene | | Gastroprotective | | | |
| | 1,8-cineole | Leaves | Antimicrobial | | | |
| | 1,8-bisabolene | | Antibacterial | | | |
| | Methyl eugenol | | Anaesthetic | | | |
| | β-caryophyllene oxide | | Analgesic | | | |
| Sterol | Stigmasterol | Stem | Antidiabetic | Stigmasterol | Stem | Antitumor |
| | β-sitosterol | Leaves | Antiinflammatory | Campesterol | Stem | Antiinflammation |
| | | | | Sitosterol | Whole Plant | Lower cholesterol |
| | | | | Sitosterol-D-glucoside | Leaves | Antifungal |
| Other compounds | | | | 16-Hexadecanoyl hydrazide | Leaves | Antidepressant |
| | | | | Phytol | Leaves | Antimicrobial |
| | | | | bis (7-methyl octyl) ester | Stem | Food packaging |
| | | | | 2-benzenedicarboxylic acid | Stem | Used to make Saccharin |
| | | | | 12-orthotrideconeoly-phorbol-13-acetate | Seeds | Antineoplastic |

## 6. Ethnobotanical uses of *O. sanctum* and *C. bonplandianum*

*O. sanctum* contains a variety of bioactive substances and may have therapeutic uses. Ethnobotanical research that documents Indigenous knowledge is crucial for both the sustainable utilization of biological resources along their conservation. Tulasi is worshipped as a goddess in Hinduism, and all parts of the plant leaves, stem, flower, root, seeds, and oil—are regarded as sacred. It is even believed that the nearby soil, which has just been demonstrated to contain helpful endophytic fungi, is a part of the divine. Because of this, a Hindi home would not be complete without a tulsi plant, usually kept in a decorative earthen pot in the courtyard. Tulsi is utilized for both utilitarian as well as ceremonial purposes[3]. For instance, the unique clove-like scent of tulsi, which comes from its high eugenol content, helps to repel flies, mosquitoes, and other dangerous insects while also connecting the householder to the holy. Rituals in the morning and evening, along with additional spiritual as well as cleansing activities that may include drinking tulsi tea or swallowing leaves, enhance the utilization of Tulsi in everyday life.

In Hinduism as well as certain Greek Orthodox churches, tulsi is employed ceremonially to produce "holy water," which also sanctifies dwelling. Tulsi's historic Ayurvedic usage, according to plant cultures, may be due to the inherent qualities of the plant's essential oils, which include eugenol and other acids with anti-inflammatory and antioxidant qualities[4]. It had been discovered that the plant originated in South America and Asia. *C. bonplandianus* has been employed for the treatment of skin conditions for example ringworm infection, respiratory problems, and bodily inflammation due to its antibacterial properties[23]. Bark as well as roots of *C. bonplandianus*'s chemical composition is cholagogue and purgative. Stems and leaves of Ban Tulsi are used to cure genital sores, diarrhea, and to stop bleeding from cuts and other bodily ailments. The seeds of this plant are used to cure internal abscesses, liver problems, severe constipation, and abdominal dropsy[24].

Its juice is used to treat headaches. In Malden's rural areas, *C. bonplandianus* has been commonly grown as well as utilized as fuel and detergent. Fuel can be made from its stems and branches. After that, ash is gathered and stored for 5 or 6 days in a container. The remaining residue has been utilized as a detergent to clean cotton clothes after dissolving in warm water. Ethnic tribes in rural West Bengal, India, use *C. bonplandianus*'s roots along with leaves to alleviate extreme heat and snake venom. According to the literature, the leaf extract is utilized to cure a diversity of conditions, encompassing venereal disease, cancer, ulcers, and more[25]. Numerous human problems can be cured by the entire plant and its various parts; these are listed in tabular form below:

**Table 2:** Common Ethnobotanical uses *O. sanctum* and *C. bonplandianus*

| S. No. | Plant part | Medicinal uses | References |
|---|---|---|---|
| 1. | Leaves | To cure:<br>Flu, Headaches, Emetic syndrome, Colic pain, Common colds, Migraine headache, Inflammation, Wound, Earache, Fatigue, Diabetes, Bronchial asthma, Snakebite, Arthritis, Skin diseases, Ulcers, Convulsions, Gastric diseases, Chronic fever, Eye infection, Malaria fever, Immunological disorders, Sore throat, Insomnia, Digestive disorders, Night blindness, Infections of mouth, Diarrhoea, Dysentery, Cold, cough, Insect bite, heart disease<br>As an antianxiety, anticancer, antidepressant, antifertility, antifatigue, antiasthmatic, antithyroid, antihelminthic<br>To stop vomiting and the negative impact of radiation. | [3, 18, 19] |
| 2. | Fruits | For flavoring foods for example poultry and fish, honey, tea and liquor, vegetables, jelly<br>Utilized in various dishes, including salads | [20] |
| 3. | Seeds | As an antiulcer, antihypertensive, larvicidal, anticancer, antiarthritic, and analgesic | [4] |
| 4. | Whole plant | For the treatment of stress, scorpion-sting, inflammation, snake bite, and diabetes<br>Function as antiseptic, antiallergic, cardioprotective, and memory enhancer | [21, 22] |

## 7. Pharmacological activity of *O. sanctum* and *C. bonplandianus*

Flavonoids, polyphenols, & essential oils are among numerous bioactive substances found in these plant parts that contribute to their pharmacological effects.

### 7.1. Antioxidant activity

Many researchers have reported *O. sanctum* L. antioxidant properties. Flavonoids' antioxidant qualities and their connection to membrane defense have been highlighted. Together with phenolic components that include isothymusin, cirsimaritin, cirsilineol, apigenin, along with rosmarinic acid that shows great antioxidant activity, *O. sanctum* L. extract of fresh leaves along with stems comprised notable levels of eugenol, a crucial part of volatile oil. Flavonoids orientin as well as vicenin showed antioxidant action in vivo by significantly lowering radiation-encouraged lipid peroxidation in mice's liver[26]. In male albino rabbits, *O. sanctum* L. aqueous extract reduces erythrocyte lipid peroxidation activity caused by hypercholesterolaemia in a dose-dependent way. Additionally, oral feeding significantly protects the aorta and leaver tissue from peroxidative damage brought on by hypercholesterolemia. Another investigation found that *O. sanctum* L. aqueous extract substantially boosts the activity of antioxidant enzymes that include superoxide dismutase as well as catalase levels in an extract-treated group in comparison with the control group[27].

Conversely, *C. bonplandianus* ethanolic extracts demonstrated DPPH and hydroxyl radical scavenging capabilities. *C. bonplandianus* leaf hydro-ethanolic extract has shown strong free radical scavenging ability. Its *C. bonplandianus* leaf chloroform fraction demonstrated a nitric oxide scavenging assay, lowering power capacity and free radical scavenging property[48, 49]. Furthermore, the n-hexane and ethyl acetate fractions of *C. bonplandianus* leaves had less antioxidant activity than the chloroform fraction. Excellent free radical scavenging activity has been exhibited by ethanolic leaf extract of *C. bonplandianus* ($IC_{50}$=170.3μg/mL); nevertheless, total antioxidant content had been determined to be 214±0.20μg/mL. Dried *C. bonplandianus* leaves ethanolic extract demonstrated a scavenging effect against free radicals and nitric oxide[50].

### 7.2. Antidiabetic activity

Diabetes mellitus is the most prevalent endocrine condition as well as has been referred to as the silent killer. Due to deficiencies in either insulin action or secretion, it is associated with a spectrum of metabolic disorders that are typified by persistent hyperglycemia and anomalies in the metabolism of carbohydrates, lipids, proteins, as well as acids. It is a medical condition in which glucose, or blood sugar, increases[46]. *O. sanctum* L.'s ethanolic extract substantially lowers glycosylated hemoglobin, blood glucose, as well as urea in streptozotocin-induced diabetic rats while concurrently raising glycogen, hemoglobin, and protein[28]. Insulin and peptide levels along with glucose tolerance increased because of these extracts. In another research, Vats[29] investigated impact of *O. sanctum* L. on 3 key enzymes that participate in the metabolism of carbohydrates: PFK (phosphofructokinase), hk (hexokinase), gk (glucokinase), as well as glycogen amount in insulin-dependent (skeletal muscle along with liver), insulin-independent (kidneys along with brain) tissues in rats given a 30-day dose of streptozotocin (STZ, 65mg/kg) to induce diabetes. When 200 mg/kg of *O. sanctum* L. extracts are administered for 30 days, approximately 9.06 & 24.4 percent declines in plasma glucose levels occur on days 15 as well as 30, correspondingly. *O. sanctum* substantially declines renal weight but not liver weight when measured as a body weight percentage. PFK, gk, as well as hk activity distributed in control of diabetic, had been largely restored by *O. sanctum* L. It had been discovered that giving an *O. sanctum* L. leaves alcoholic extract orally notably reduced blood sugar levels[3]. The antidiabetic properties of *C. bonplandianus* are not typically documented in its plant extracts.

### 7.3. Nootropic activity

Nootropic drugs improve memory, focus, and processing speed, among other aspects of cognitive function. Numerous substances found in *O. sanctum*, including carvacrol, rosmarinic acid, and eugenol, have been demonstrated to possess nootropic properties. *O. sanctum* has the potential to enhance cognitive abilities. By lessening chronic stress's detrimental impact on the brain, its adaptogenic properties, which promote the adaptation of stress as well as the reduction of anxiety, may subsequently assist in improved cognitive function[30]. In mice, Joshi and Parle[21] evaluated the extract from *O. sanctum's* potential as a nootropic as well as anti-amnesic. The mice were given an aqueous extract of the entire plant of *O. sanctum* L., which prevented the amnesic effects of scopolamine (0.04mg/kg), and diazepam (1mg/kg), along with age-induced memory degradation. Exteroceptive behavioural models were the passive avoidance paradigm and the elevated plus maze. In mice, *O. sanctum* L. extract substantially lowered transfer latency as well as enhanced step-down latency in comparison to the scopolamine, control (piracetam-treated), and elderly groups. Therefore, *O. sanctum* L. preparation might be valuable in the treatment of cognitive diseases like Alzheimer's and dementia. A 400mg/kg intraperitoneal (ip) *O. sanctum* root extract's methanolic extract lengthens the mouse's swimming time in a despair swim test paradigm, indicating *O. sanctum* L. possess anti-stress and/or central nervous system stimulant properties[31]. The plant extracts of *C. bonplandianus* have not been commonly reported to possess nootropic activities in current literature.

### 7.4. Gastroprotective activity

Standardized methanolic extract of *O. sanctum* leaves (OSE) exhibited a dose-dependent ulcer preventative effectiveness against stomach ulcers produced by cold-restraint stress when taken orally 2 times daily for 5 days at dosages ranging from 50-200 mg/kg. According to Goel[32], the optimal effective dose of OSE (100 mg/kg) demonstrated considerable ulcer protection against gastric ulcers caused by ethanol as well as pyloric ligation, but it had been inefficient against ulcers caused by aspirin. Additionally, OSE (100 mg/kg) enhances the longevity of mucosal cells, cellular mucus, and mucin secretion, while suppressing the production of lipid peroxidation and the unpleasant acid pepsin. Rats with pyloric ligation and aspirin treatment were used to test *O. sanctum*'s antiulcerogenic properties. Seven days prior to therapy, the extract boosted mucus secretion and decreased ulcer index, free, and total acidity when administered acutely and chronically. Because *O. sanctum* extract can increase mucus secretion and decrease acid secretion, it can be said to have anti-ulcerogenic properties against experimental ulcers[33]. Gastroprotective properties are not frequently present in the different parts of the *C. bonplandianus*.

### 7.5. Antimicrobial activity

The greater quantity of linoleic acid in *O. sanctum* fixed oil may have contributed to its antibacterial qualities, mentioning Singh et al.'s investigation. The oil exhibits strong antibacterial activity against *Pseudomonas aeruginosa*, *Bacillus pumius*, *Staphylococcus aureus*, with *S. aureus* being the most susceptible. Likewise, it was discovered that *O. sanctum* was effective against strains of *Neisseria gonorrhoea* that were resistant. In contrast to the alcoholic extract, Geeta et al. discovered that the aqueous extract of *O. sanctum* (60 mg/kg) displays extensive zones of inhibition against *Proteus* spp., *Escherichia. coli*, *Candida albicans*, *Klebsiella* spp., as well as *Staphylococcus. aureus* when evaluated utilizing agar diffusion approach. Alcoholic extract exhibited a greater *Vibrio cholerae* zone[34].

To investigate the antibacterial properties of *C. bonplandianus* leaves, fruits, latex extracts, and fresh latex, 500mg of every extract was combined with 5ml of sterile 10 percent DMSO (dimethyl sulfoxide) to make 10% w/v test solutions of the plant's leaves, fruits, and latex. To assess fresh latex, extracts from the same source were used to determine that 25, 50, 75, and 100 had 2.5, 7.5, and 10 mg of antibacterial activity, respectively. At various concentrations (2.5, 5, 7.5, & 10mg), *C. bonplandianus* whole plant and latex extracts were added to each well of Mueller Hinton Agar (MHA) plates that had already been infected with the relevant bacterial cultures. At 37 ºC plates had been incubated for a whole day. Streptomycin (10 µ g) served as the positive control group in this investigation, while 10% DMSO served as the solvent. A zone reader was used to measure the diameter of the inhibition zone (in millimeters) surrounding the well following incubation[42]. The best results were achieved at 7.5mg/75 µl when the antibacterial activity of several solvent-extracted extracts of *C. bonplandianus* leaf were examined against bacterial isolates. When contrasted with other bacterial isolates, aqueous leaf extract demonstrated a minimum zone of inhibition of 10±1mm against *P. aeruginosa* as well as the maximum zone of inhibition of 15±2 mm against *S. aureus*[43]. Several bacterial isolates were treated with ethanolic leaf extract; the results showed that *E. acrogens* and *E. coli* had the highest zone of inhibition, that is 22±2 mm, while *E. faecalis* had the lowest zone of inhibition, that is 16±2 mm. The leaf acetone extract's smallest zone of inhibition was 10±1 mm, while its largest zone of inhibition against *E. acrogens* and *E. coli* was 19±2mm. The leaf extract in chloroform showed inhibition of 19±2 mm against *E. coli* and *S. aureus*, but the leaf extract in benzene showed inhibition of 20±2 mm against *S. aureus*[44]. As per the National Committee for Clinical Laboratory Standards (1997), agar disc diffusion technique was utilized to examine the invitro antibacterial activity of aqueous extracts (say) of *C. bonplandianus* against 3 strains of Gram-positive along with 4 strains of Gram-negative bacteria. Potent antibacterial action against a variety of harmful bacteria has been demonstrated by several antibiotics made from plant extract. *C. bonplandianus* possesses antimicrobial and genotoxic properties. In the anaphase and telophase stages, the root tip cells *Allium* exhibited a 24.17% aberration due to the leaf aqueous extract. However, 22.08% and 21.55% aberration were produced by methanolic and acetone extracts, respectively. *C. bonplandianus* leaf & fruit's methanolic extract have been more efficient against microbes for example *Pseudomonous aeruginosa, Bacillus subtilis, E. coli, Klebsiella pneumonia*, along with *S. aureus*. Most efficient against *B. subtilis*, *P. aeruginosa*, *E. coli*, *Proteus vulgaris*, *B. megaterium*, as well as *S. aureus* had been *C. bonplandianus* leaf extracts prepared in chloroform and benzene[25, 45].

### 7.6. Anti-inflammatory activity

*O. sactum*'s methanolic extract (500 mg/kg) as well as aqueous suspension demonstrated analgesic, antipyretic, & anti-inflammatory activities in rats with acute (carrageenan-induced pedal edema) along with chronic inflammations. The fixed oil and linolenic acid have potent anti-inflammatory activities against PGE2, leukotriene, and arachidonic acid-induced paw edema in rats because they may block cyclooxygenase as well as lipoxygenase pathways of arachidonic acid metabolism[35].

An estimation of the *C. bonplandianum* leaf ethanolic extract was conducted on human blood vessel membranes. About 83.2% was prevented from hypotonicity-induced human blood vessel membrane lysis by ethanolic extract (200 mg/mL). An assessment was conducted on the anti-inflammatory features of *C. bonplandianum* hydro-alcoholic leaf extract. Rat model of pow edema produced by carrageenan After four hours of treatment, a hydro-alcoholic *C. bonplandianum* leaf extract notably reduced rat paw edema caused by carrageenan[53].

### 7.7. Anticancer activity

Numerous researchers have demonstrated and cited anticancer properties of *O. sanctum* Alcoholic extract (AlE) from *O. sactum* leaves modulates carcinogen-metabolizing enzymes that include cytochrome b5, cytochrome P 450, aryl hydrocarbon hydroxylase, GST (glutathione S-transferase), that have been essential for the detoxification of carcinogens as well as mutagens. Benzo(a)pyrine-induced neoplasia of mouse forestomach along with 3'-methyl-4-dimethylaminoazobenzene-induced hepatomas in the rats were substantially reduced by OS[36]. It has been demonstrated that the AlE in OS leaves inhibits chemically produced cutaneous papilloma in mice. Fresh Tulsi leaf paste taken orally might be capable of stopping the initial stages of buccal pouch carcinogenesis caused by DMBA. OS leaf extract inhibits the carcinogen's metabolic activity, hence blocking or suppressing the events linked to chemical carcinogenesis. The anticancer properties of *O. sanctum* have been identified in Swiss albino mice with EAC (Ehrlich ascites carcinoma) & S 180 tumors. The incidence and volume of tumors caused by 20-methaylcholathrene were considerably decreased by supplementing with the oil at the maximally tolerable dose of 100 µl/kg body weight. Mice given seed oil treatment showed an improved rate of survival and a delay in the occurrence of tumors. The chemo-preventive effectiveness of 80mg/kg vitamin E had been equivalent to that of 100µl/kg seed oil. Seed oil's antioxidant properties have been partially linked to its possible chemo-preventive effects[37].

The Euphorbiaceae family includes the green shrub *C. bonplandianus*, which is native to Southeast Asia. Croton oil's main active ingredient, 12-O-tetradecanoylphorbol-13-acetate, has been used as a cancer promoter region because it causes irritation and inflammation when applied topically to mice's skin that has previously been exposed to 7,12-dimethylbenz(a)anthracene or other aromatic polycyclic substances (typical dose: 5–16 nmol, twice a week). TPA has been shown to limit growth, induce apoptosis, or stimulate development in human malignant cells isolated from individuals with melanoma, lung, breast, or prostate tumours. This data comes from a thorough tumor investigation. Prostate cancer cells known as LNCaP treated with the right amounts of TPA (1-1.6NM) have shown inhibition of growth. Nevertheless, the same cells that were given TPA at dosages that were significantly higher showed signs of apoptosis. TPA and ATRA together have been shown to restrict the growth of cultured prostate cancer LNCaP cells, whilst TPA or ATRA therapy was found to inhibit the growth of existing LNCaP tumors in immunodeficient animals. All of the treated animals experienced some tumor regression when TPA along with ATRA was given to these mice with tumors, though some of the treated mice experienced tumor regressions[13].

### 7.8. Anti-fertility

*O. sanctum* leaf benzene extract has a reversible antifertility action because it reduces sperm motility, forward velocity, and total sperm count when taken at a dose of 250 mg/kg body weight for 48 days. While the percentage of abnormal sperm in the caudal epididymal fluid rose, the fructose content of seminal vesicles as well as the caudal plasma of epididymis declined. All these readings reverted to normal 2 weeks after the medicine had been withdrawn[38]. Currently, there is no documented evidence or research indicating that *C. bonplandianus* exhibits any properties that inhibit fertility.

### 7.9. Immunomodulatory effect

The rich phytochemical composition of *O. sanctum*, which includes polyphenols, essential oils and flavonoids has been demonstrated to possess immune-enhancing qualities and is linked to its capacity to regulate the immunological response. Albino rats' humoral immune response had been altered through a steam-distilled extract from fresh OS leaves. This might be explained by a number of processes, including the creation of antibodies, the release of hypersensitive reaction mediators and the target organs' tissues' reactions to these mediators[26]. The immunomodulatory effects of *O. sanctum* seed oil, which appear to impact humoral and cell-mediated immune response, might be mediated by GABAergic pathways. The leaves of *O. sanctum* stimulate the humoral immunogenic response, as demonstrated by the cellular immunologic response, demonstrated by lymphocytosis and the formation of E-rosette, and by a rise in antibody titer in sheep erythrocyte agglutination and Widal tests[34]. In the course of the comparison between the two plant species, it was observed that the immunomodulatory effects exhibited by *C. bonplandianus* were significantly less pronounced than those of its counterpart. This finding suggests that *C. bonplandianus* may not be as effective in modulating immune responses, highlighting the need for further investigation into its potential therapeutic applications and mechanisms of action.

### 7.10. Central Nervous System (CNS) depressant activity

Pentobarbital (40 mg/kg, ip)-induced mice's loss of reflex was prolonged by *O. sanctum's* AlE, which also reduced the duration and intensity of electroshock and convulsions caused by pentylenetetetrazole. In "open field" trials, it also reduced ambulation and fighting time caused by apomorphine. OS extract enhanced swimming time at high doses, indicating CNS stimulant or else antistress effect. The impact had been equivalented to that of desipramine, an antidepressant drug. It has been demonstrated that rats administered OS fixed oil (2–3ml/kg, ip) sleep longer when given pentobarbitone. The increase in pentobarbitone-induced sleep duration may be caused by fixed oil's suppression of pentobarbitone's hepatic metabolism and renal clearance[39]. The findings suggest that *C. bonplandianus* may have a constrained ability to influence reflex actions. This highlights the necessity for more in-depth research to gain a clearer understanding of its possible therapeutic benefits and the underlying mechanisms that drive its effects. Such investigations could be essential in revealing the full scope of its potential applications in medical science.

### 7.11. Antiarthritic activity

Rats with formaldehyde-induced arthritis were used to test *O. sanctum* fixed oil's antiarthritic properties. The fixed oil substantially declined the diameter of an irritated paw. Rats' arthritic conditions significantly enhanced after receiving the fixed oil intraperitoneally every day for ten days. Aspirin at a dose of 100mg/kg had antiarthritic impact that had been alike to that of 3ml/kg, ip41. Inflammatory as well as carrageenan mediators, for example, histamine, serotonin, PGE2, & bradykinin, were suppressed by the fixed oil. Naturally, any inflammatory reaction involving these mediators may be inhibited by the oil. The outcome indicates that the inflammation models, which include adjuvant and turpentine oil-induced joint edema in rats, may have beneficial antiarthritic properties[40]. At present, there is a notable absence of documented evidence or scientific research that supports the claim that *C. bonplandianus* possesses any properties capable of influencing or controlling anti-arthritic activity.

### 7.12. Adaptogenic activity/antistress activity

The adaptogenic action of plants might be due to *O. sanctum's* immunostimulant potential. The OS whole plant's AlE enhanced swimming mice's physical endurance (survival time) inhibited stress-induced ulcers in rats, as well as stopped mice's milk-induced leucocytosis. These findings suggest that *O. sanctum* increases animals' non-specific resistance to a range of stress-induced biological changes[41]. Currently, there is a significant lack of documented evidence or scientific studies that substantiate the assertion that *C. bonplandianus* has such properties that can affect or regulate adaptogenic activity. This absence of research leaves a gap in our understanding of the potential benefits of this plant and highlights the need for further investigation into its characteristics and effects.

### 7.13. Wound healing activity

In everyday life, wounds are typical clinical entities that may vary in size from small to large. Five steps can be distinguished in the wound healing process: collagenation (cellular phase), contraction (wound contraction), collagen deposition (collogenation), epithelialization (epithelialization), as well as scar remodeling (cicatrixization). Wound contraction is the process by which the wound area shrinks, while wound healing is the process by which damaged tissue is returned as nearly to its normal state as feasible. In accordance with Ramachandran[46], the alcoholic leaf extract of *C. bonplandianus* substantially raises the pace of wound concentration. They concluded that herbal extract ointments containing leaf extracts from *C. bonplandianus* substantially boost the rate of wound concentration[55]. At present, there is a considerable deficiency of documented evidence and scientific research that verifies the notion that *O. sanctum*, commonly referred to as holy basil, has any significant properties that can influence or improve the process of wound healing. This lack of rigorous studies and data not only leaves a conspicuous void in our comprehension of the potential therapeutic benefits offered by this remarkable plant but also emphasizes the urgent need for comprehensive research to explore its characteristics, mechanisms, and effects related to wound regeneration and healing processes.

## 8. Conclusion

The ancient practice of phytomedicine represents the earliest known form of medicine, relying on the healing properties of plants. Among these plant-based remedies, *O. sanctum*, commonly known as Tulsi, and *C. bonplandianus* stand out for their extensive use in ethnomedical practices across the globe, where they are employed to treat an array of ailments. Rooted in the rich biodiversity of India, Ayurvedic medicine uniquely draws upon a diverse spectrum of medicinal and culinary plants that few other medical systems can claim. Tulsi, in particular, is lauded not only for its specific therapeutic applications but also for its remarkable adaptogenic qualities. These properties confer significant preventive and curative benefits, particularly against the stress-related degenerative diseases prevalent in modern industrialized societies. Ongoing clinical research is anticipated to further uncover and validate Tulsi's numerous health-promoting attributes. Recent studies have revealed a wealth of diverse phytochemicals in various parts of *C. bonplandianus*, including its fruit, leaves, and latex. Altogether, a total of twenty-one key phytochemicals has been identified, underscoring the plant's medicinal potential. The extensive literature surrounding traditional and ethnomedical practices highlights both the remarkable efficacy and safety of these plants in addressing a wide range of health issues. However, a deeper exploration is essential to better differentiate, describe, and clarify the intricate chemical profiles of the bioactive compounds that endow *O. sanctum* and *C. bonplandianus* with their therapeutic effects. By employing advanced reverse pharmacological techniques, researchers can extract potent and safe medicinal compounds from these plants, paving the way for the development of innovative natural drugs.

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## Author contributions

SS – Research concept and design, PB – Collection and assembly of data, Data analysis and interpretation, Writing the article, SS, PB– Critical revision and final approval of the article.

## Data Availability

Not Applicable.

## Conflicts of interest

The authors declare that there are no conflicts of interest related to this article. No ethical issues.

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# Dwindling Field Botanists at the Cost of Wet Lab Fundings in India: A Threat to Botanical Science and Biodiversity Conservation

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## Abstract

Classical Field botanists have long been India's foremost source of botanical information for the investigation, authenticating, and conservation of the country's flora. India is well-known for its wide-ranging phytodiversity and rich plant legacy. Over the past few years, there has been a worrying decline in the numbers of field botany research steered in India. This has far-reaching insinuations for the conservation of phytodiversity and the understanding of ecological processes. There has been a drive in preferred funding towards molecular biology and biotechnology, which has resulted in the negligence of the crucial work of documenting and maintaining plant species in their natural environments. This tendency not only makes it more problematic to find new species, but it also makes it more tough for botanists to keep an eye on and defend the species that have already existed. The decline in traditional botanical knowledge, which has been passed down through cohorts of field botanists, makes the problem even worse. This loss of information has the possibility to lead to undesirable breaks in our understanding about plant ecology, dispersal, and environmental interactions. Several fields, including horticulture, agriculture, pharmaceuticals, and environmental administration, are among those that will be affected by this alteration, which has impacts that exceed beyond the realm of academic circles. Without all-inclusive field studies, the skill to identify valuable plant characters for medications or crop upgrading is inadequate. The deficiency of up-to-date botanical data also hampers actual protection and ecosystem supervision. Tackling these encounters needs strategies that poise field and lab research—via devoted backing, amalgamation of conventional and contemporary methods, and alliance among field botanists and molecular biologists to better appreciate India's phytodiversity.

**Keywords:** Field botany, Funding, Phytodiversity conservation, Regional flora, Molecular Biology.

## 1. Introduction

India is an amiable home to an incredible phytodiversity that goes beyond the 18,000 species of flowering plants that are already reported to exist. The well-known biodiversity hotspots of India hold a great deal of probable for forthcoming findings[1]. Several plant species that have not been documented can be found in the Eastern Himalayas, Andaman-Nicobar Islands, and the Western Ghats. These areas are notable by their diverse but distinct ecosystems and their peculiar geographical remoteness which offer these locations a diverse landscape, specific microclimates, and controlled human disturbance that are the perfect conditions to establish and to evolve indigenous flora. As a result, these conserved areas are good targets for botanical research and study[2].

The retardation in research related to field botany in India has serious consequences for the safety of biodiversity and the acquaintance of ecological systems.

In the recent past amazingly there has been a movement in funding towards molecular biology and biotechnological research projects, which has ensued in the negligence of the crucial work of documenting and upholding plant species in their natural environments. The All India Coordinated Project on Taxonomy seems to be the last such effort in the early 2000s by the Ministry of Environment and Forests, Government of India, which was focused on capacity building in the field of botany[3]. During that project, researchers had been trained in plant taxonomy; however, except for a few of them, most of the trained persons could not get the position of scientist in the Botanical Survey of India and other institutes. This is an irony that a trained person is not getting a job with his/her expertise, for which he/she devoted important years of life. Besides this, it is quite difficult for the faculty also to get grants for the projects related to classical botany.

This drift not only makes it more tough to find new species, but it also makes it more problematic for us to keep an eye on and protect the species that already exist. The decline in traditional botanical knowledge, which has been propagated through generations of field botanists, makes the situation even worse. This lack of information has the probable to lead to gaps in our contemplation regarding plant ecology, interactions, and distribution within ecosystems. Several related fields, comprising agriculture, herbal drug, and environmental management, are among those that will be obstructed by this disagreeable transformation, which has consequences that rise above beyond the academia.

Without systematic field research, we are strictly limited in our capability to identify and exploit valuable plant characteristics for the creation of medications or crop improvement. Furthermore, the lack of latest botanical data hampers the creation of effective conservation plans and strategies for ecosystem management. To address these issues when they arise, policy procedures that indorse a well-adjusted approach amid laboratory and field sciences must be put into place. To attain a more exhaustive understanding of plant biodiversity, this may necessitate providing specialized funding for field botany research, integrating traditional botanical techniques with contemporary technologies, and inspiring cooperation concerning molecular biologists and field botanists.

## 2. Field Botanists' Contribution to India's Botanical Heritage

The Botanical Survey of India (BSI), the Forest Research Institute (FRI), and several universities and allied institutions are among the groups that were once centers of concentrated fieldwork. Their work laid the basis for India's national biodiversity plans, which were later put into effect. Field botanists contribute suggestively to our understanding of plant biodiversity and ecosystems. Several scientific and practical applications help from their expertise in identifying, sorting, ordering, and gathering plant species in their natural environments. Field botanists play a decisive role in the creation of all-inclusive flora and plant monographs, which serve as indispensable references for researchers, conservationists, and policymakers[4]. Furthermore, their research aids in the expansion of conservation plans and ecological rebuilding projects, which support the protection of threatened plant species and delicate ecosystems.

The aids of practicing botanists excel the boundaries of virtuous scientific knowledge. Their efforts are critical to the protection of ethnobotanical knowledge, which includes the routine uses of plants for a range of purposes, such as medicinal, cultural, and economic ones. Because it may result in the identification of species with noteworthy ecological, agricultural, and medicinal value, this suggestion is particularly beneficial for indigenous populations. Establishments such as the Forest Research Institute (FRI), the Botanical Society of India (BSI), and numerous academies have been at the vanguard of conducting all-embracing fieldwork since the commencement of time. The basis for our present-day knowledge of plant diversity and distribution has been recognized by this[5].

These institutions have played a vital role in the teaching of many generations of practicing botanists and in upholding vast herbarium collections that remain treasured resources for contemporary research and protection efforts.

### 3. Field Botany Decline: Patterns and Proof

The general acceptance that fieldwork is obsolete or less imperative than laboratory-based research is known as "side-lining." Field botanists contribute pointedly to our understanding of plant biodiversity and ecosystems. The contributions of practicing botanists excel the boundaries of purely scientific knowledge. Their efforts are decisive to the preservation of ethnobotanical knowledge, which involves the customary uses of plants for a range of purposes, such as medicinal, cultural, and economic ones. Because it may result in the documentation of species with noteworthy ecological, agricultural, and medicinal value, this information is particularly valuable for indigenous populations[6]. Throughout past, several universities, and dedicated research institutes such as the Botanical Survey of India (BSI) and Forest Research Institute (FRI), have been at the leaders of all-embracing fieldwork. The footing for our present acquaintance of plant distribution and diversity was established by these national organizations. These organizations have played a vital role in the training of several groups of practicing botanists and in maintaining vast herbarium collections that remain valued possessions for contemporary research and conservation efforts.

### 4. Bias in Funding and Policy for Wet Labs

Both botanical research and conservation efforts are pointedly obstructed by the prominence on molecular approaches in terms of backing and funding policy. The sharing of resources has become significantly unstable because of the thrust areas like proteomics, genomics, and gene editing technologies like CRISPR. Equated to more orthodox institutions like field stations and herbariums, molecular laboratories have gotten an unequal expanse of support. This inequality affects not just how funds are distributed but also how research primacies are set and how scientific knowledge attains cutting-edge. Moreover, most of the erudite apparatus found in botany labs—such as the scanning electron microscope (SEM), the microtome, and other similar classical instruments are either out-of-date or impractical due to a lack of money. In addition to triggering financial discrepancies, this prejudice in wet labs has other consequences also. For Instance, a key element of the scientific method is the capability to reproduce and authenticate scientific findings, which is hindered by the failure to gather voucher specimens. Also, a worrying trend has resulted from the undervaluation of plant taxonomy, even ecological research now profoundly depends on automated or unconfirmed species identifications in the era of artificial intelligence. The exactness and reliability of assessments of biodiversity may be endangered by this lack of gratitude. Funding requests related to biodiversity that give DNA barcoding precedence over conventional taxonomic techniques further highlight this change in importance. As a result, there is a likelihood that crucial morphological and ecological information that cannot be captured through molecular techniques alone would be ignored.

### 5. Implications for Conservation and Biodiversity

The loss of newly revealed species is not the only factor causative to the decline in botanical expertise. As such, it impacts our capacity to comprehend and efficiently manage whole ecosystems. Because they don't fully recognize plant diversity, investigators find it stimulating to appraise the pliability and health of ecosystems. They might thus oversee significant indicators of ecological change. Unproductive responses to ecological issues like climate change, offensive species, and other ecological pressures may arise from the partial understanding of the complicated relationships that exist among plants and their environments. Another interesting facet is that the loss of botanic knowledge has consequences for many different scientific areas and industries, for instance, pharmaceutical research, which often exploits molecules derived from plants, may miss chances to create new drugs.

Agricultural inventions may be hindered by a lack of systematic understanding of plant genetics and ecology, particularly when it comes to crop improvement and pest control. Additionally, the field of ethnobotany, which studies in what way aboriginal communities have conventionally used plants, faces the risk of losing imperative knowledge about cultural and medicinal customs connected to the local flora. As our botanical skill declines, so does our capability to fully identify and exploit the plant world's massive potential for scientific, economic, and cultural benefits[7]. Deprived field data can lead to a decrease in strategical support, which has major penalties for ongoing conservation efforts. Because they lack admittance to precise and up-to-date field data, legislators are often forced to trust in inadequate or obsolete data. Consequently, conservation tactics are created that are either unproductive or imprecise. The inappropriate distribution of resources due to a lack of knowledge may cause chief habitats or threatened species to be ignored.

The lack of all-inclusive field data makes it more thought-provoking to track and respond to rapidly shifting environmental conditions, which is predominantly challenging given the occurrence of climate change. The efficiency of initiatives to conserve phytodiversity may ultimately be threatened because of conservation programs' inability to cope with recently discovered threats or adjust to altering ecological dynamics. The loss of conventional ecological acquaintance has significantly laden our understanding of local ecosystems and sustainable resource management techniques. This, along with a decline in field skill, poses numerous significant challenges in present day botanical explorations. Botanists and field researchers bear a major accountability for authenticating and conserving indigenous knowledge regarding the use of plants, cultivation methods, and cultural practices related to local flora[7]. This invaluable acquaintance has been gathered over many generations and often contains the surreptitious to both potential discoveries in a few selective fields like ethnopharmacology and sustainable land management. As this knowledge endures to worsen without being sufficiently recognized and incorporated into scientific study, we are at risk of losing invaluable insight into the dynamics of environmental problems and possible solutions to environmental anxieties. The importance of upholding and growing field expertise is further highlighted by the growing effects of climate change and habitat degradation, which are radically changing ecosystems and abolishing biodiversity at a rapid rate never seen.

## 6. The Path Ahead: Overcoming Disparities

To tie the gap amid field botany and molecular biology, a multifaceted tactic is desirable. Revitalizing interest in field botany is decisive, and the first step in doing so is to make field training a prerequisite for undergraduate and graduate programs. This practical knowledge will expose students to the practical aspects of botany and help them to develop a greater indebtedness for field work. Additionally, the facility of fellowships and jobs in the field of plant sciences might result in the delivery of excellent opportunities for prospective botanists to get practical knowledge and contribute to continuing research projects.

Another vital step that needs to be taken to address the current inequity is rebalancing the funding for plant-based research. If we mandate that a explicit percentage of the funds for biodiversity research be used for field-based activities, we can safeguard that critical field studies by providing required resources[8]. This method should be reinforced by assisting with long-term ecological monitoring plots and herbaria digitization projects, which afford decisive information for field and molecular botanists and plant biotechnologists. Additionally, the expansion of partnership amid molecular labs and field botanists depends on the reassurance of knowledge and practice sharing between the two vital groups, which requires the support of organizations and plans[9].

Field botany may become more attractive and more fruitful if it makes better use of digital tools like GPS mapping, drone surveys, and artificial intelligence-assisted methods. Reinforcement of the institutions which are dedicated to botanical research and education will provide a robust foundation for the field of botany's ongoing growth and development[10]. The following suggestions might be helpful in this direction:

1. Field training should be compulsory for both undergraduate and graduate students.
2. Offer grants and placements in the botanical sciences.
3. Demand that field-based research be reinforced with a specific and dedicated percentage of the funds allotted for biodiversity research considered as thrust areas.
4. Funding should be offered for the digitization of herbaria and long-term ecological monitoring designs.
5. Alliances between molecular botanists and field botanists should be encouraged.
6. To revolutionize classical botany, use of digital methods like drone surveys, GPS mapping, and AI-assisted approaches should be recommended.

7. Monetary and human possessions should be made accessible to strengthen establishments such as the BSI, FRI and state herbaria.

## 7. Conclusion

Contemporary research laboratory skills must be united with conventional field botany to assure India's continual accomplishment in the botanical world. The circumstantial and ground-truthing data that field botany provides cannot be replicated by molecular skills. To appropriately understand DNA data and create all-inclusive conservation plans, field botanists are imperative for thorough understanding of ecosystems, plant relationships, and local biodiversity. The use of modern laboratory techniques improves our understanding of botanical diversity at the molecular level by providing hitherto unattainable insights into plant genetics, evolution, and biochemistry. To protect India's botanical inheritance, organisations, educational establishments, and financial agencies must stand-in the reciprocal beneficial relationship between field botany and laboratory sciences. This amalgamation is vital for national biodiversity protection. If it promotes collaboration between molecular botanist and field botanists, India could create wide-ranging tactics to plant taxonomy, ecology, and conservation. The identification of new plant species that may have considerable marketable or therapeutic value, the control of invasive species, and the effects of climate change on flora are just a few of the encounters that will require this multidisciplinary method. The future of Indian botany lies in creating researchers who are equally skilful at molecular analysis and field observations. This will promise a complete understanding of the country's rich botanical resources.

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## Authors Contributions

RKD conceptualized the study, and PC was responsible for data compilation. Both authors reviewed and approved the final draft prior to submission.

## Data Availability

No new data was generated or analyzed in this study. Data sharing is not applicable to this article.

## Conflicts of interest

The authors declare no conflict of interest.

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Research Article

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# Forest Flora of Haryana: An Annotated Checklist

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## Abstract

Floristic composition across diverse geographic regions naturally changes over time naturally at a slower pace. However, the ongoing anthropogenic activities significantly impact these changes, usually towards negative side. This makes systematic monitoring crucial for effective protection of diversity and sustainable management. The Convention on Biological Diversity (CBD) underlines the significance of periodic biodiversity assessments. Prevailing Forest Floras provide vital information on regional woody plant species, but due to enduring ecological shifts, updated documentation is obligatory for adaptive strategies. In Haryana, floristic studies date back to the 19th century, with contributions from several botanists and institutions over the years. In spite of various scattered studies on the region's plant diversity, all-inclusive data on the forest flora of Haryana has been lacking. The current checklist treatises this gap by documenting 512 species of angiosperms and gymnosperms found in Haryana's forests, including 227 tree species, 203 shrubs, and 82 climbers. This work forms a strong baseline for future floristic research, conservation efforts, and sustainable utilization of the state's forest biodiversity.

**Keywords:** Floristic diversity, Forest Flora, Haryana, Biodiversity monitoring, Angiosperms, Gymnosperms.

## 1. Introduction

Changes in the floristic diversity of different geographical locations over the years are imminent. However, owing to various anthropological factors, the rates of such change have increased, depending upon the intensity of anthropogenic and other factors of any area. Therefore, it is recommended that floristic diversity should be monitored at regular intervals, so that need based conservational or other actions may be taken up. The Convention on Biological Diversity (CBD), has also asserted the need for inventorization and monitoring of biodiversity at regular intervals for planning and sustainable utilization. Already existing Forest Floras provide valuable information about the woody floristic composition of the given region. However, over the years, due to various factors, species composition of the areas keeps on changing, thus demanding for updated documentation for making suitable strategies for management and conservation. Forest Flora contains invaluable information about the woody flora of the region. After the emergence of taxonomic research in India, several Forest Floras have been published by time to time by several Botanist includes Steward and Brandis[1], Beddome[2], Talbot[3], Kanjilal[4], Parker[5], Osmaston[6], Kanjilal[7], Haridasan and Rao[8], Naithani et al.[9], Naithani[10] Krishen[11] and Page et al.[12].

The state of Haryana was formed on the first of November 1966 because of reorganization of erstwhile Punjab.

The earliest record of plants from Haryana is found in Royle's[13] 'Illustrations of botany and other branches of the natural history of the Himalaya Mountain of the *Flora of Kashmir*'. J.L. Stewart published a book on "*Punjab Plants*"[14] and Aitchison published a list of the plants of Hoshiarpur district[15]. Their collections are housed in the Herbarium of Forest Research Institute, Dehradun. A few sheets of J.R. Drummond from Haryana are also preserved there. J.F. Duthie made a few references to the plants of Karnal, Kurukshetra, Hissar and Ambala in his "Flora of the Upper Gangetic Plains and of the Adjacent Siwalik and Sub – Himalayan Tracts"[16].

Collett[17] published '*Flora Simlensis*' which covers the flowering plants of Simla and the neighborhood areas. A catalogue of the principal trees and shrubs of the Punjab was published by Conventry[18]. Bamber[19] published "Plant of Punjab" and Kanjilal and Gupta[20] made some references to the plants of north–east Haryana in their "Forest Flora of Chakrata, Dehradun and Saharanpur Forest Divisions, Uttar Pradesh". Sabnis[21] published the 'Flora of Punjab Plains and the Associated Hill Regions'. Among other significant publications worthwhile mentioning are Kaul[22,23].

Yadav and Singh[24] have worked on sedges and grasses of Kurukshetra. Several other workers have also contributed by publishing the checklists and new records on the flora of Haryana. The floristic wealth of the state has also been partly explored in the past in various floras and several theses have been completed on various districts of the state[25-32].

Jain[33] has described 1003 species of angiosperms belonging to 586 genera and 132 families. Kumar[34] has given a list of 1062 species under ca 583 genera representing 138 families. Recent past, Negi et al.[35] have explored the Siwaliks of the state and published a Floristic diversity of the Siwaliks of Haryana. Apart from that, some sporadic work on floristics of Haryana has also been done by various workers from time to time [36-58], but no concrete and consolidated data is available on the floral wealth of the forest. However, for judicial utilization of floristic diversity of the forest, the present checklist enumerated 512 species of angiospermic and gymnospermic plants which includes 227 Trees, 203 Shrubs and 82 Climbers.

## 2. Materials and Methods

The states of Punjab, Himachal Pradesh, Uttar Pradesh, Delhi, and Rajasthan enclose Haryana. It features some outcrops of the Aravalli hill ranges in the south-west and a tiny northern section with hills of the Shiwalik range of the Himalaya. However, the fertile Indo-Gangetic Plains comprise most of the region. The drainage system is made up of the Saraswati, Markanda, and Tangri rivers along with their tributaries, as well as the Yamuna in the east and the Ghaggar in the west.

The state of Haryana is located between latitudes 270 39' and 300 55' N and longitudes 740 28' and 770 36' E. Its overall size is approximately 44,222 square kilometers. The tallest mountain is located at Morni in the Ambala district, and the elevation ranges from 225 to 1500 meters above mean sea level.

According to FSR 2021, the State's total forest cover is 1,559 km$^2$, of which 28 km$^2$ are in extremely dense forest, 445 km$^2$ are in moderately dense forest, and 1,130 km$^2$ are in open forest. Ten Sub-Forest Types are further subdivided into the three Forest Type Groups—Tropical Dry Deciduous Forest, Tropical Thorn Forest, and Subtropical Pine Forest—that comprise the forests of Haryana (Figs. 1-3).

**Figure 1.** Views of different type of Forest vegetation at Shiwalik range of Haryana

**Figure 2.** Views of different type of Forest vegetation at Aravalli Range of Haryana

**Figure 3.** Views of different type of Forest vegetation at plains of Haryana

The systematic survey has been conducted in various seasons at various locations, including Ambala, Kaithal, Kurukshetra, Yamuna Nagar, Morni-Pinjore, Jind, Hisar, Fatehabad, Bhiwani, Sirsa, Gurugaon, Faridabad, Palwal, Mewat, Rewari, Mahendragarh, Rohtak, Karnal, Panipat, Sonipat, and Jhajjar, to obtain comprehensive information on the species distributed in the various forest divisions of Haryana. From 2015 to 2017, in-depth field surveys were carried out throughout Haryana. Plant specimens were gathered for the surveys using the floristic survey standard procedure with field notes. With the aid of several wild floras, the plants were recognized. The Forest Research Institute's DD Herbarium in Dehradun, Uttarakhand (India) provided the verified plant specimens.

For the convenience of the readers, excellent quality photos of the plants that were taken during the field surveys have also been added to this article in 54 photo plates where the plants are arranged alphabetically. Similarly, a thorough table containing all pertinent information about the plants on the list is also accessible (Table 1).

## 3. Results

Following a thorough field survey conducted in Haryana from 2015 to 2017, the entire region was examined and divided into three zones:

**3.1. The Aravalli Ranges and Sandy tracts:** It is India's oldest fold mountain range, an eroded stub of ancient mountains. Haryana's Northern Aravalli range experiences hot, semi-arid continental summers and comparatively cold winters due to its humid subtropical climate. The low hills known as the Aravallis stretch from Delhi's boundaries to Rajasthan via the districts of Faridabad, Mewat, Gurgram, Rewari, Mehendragarh, and Bhiwani. Most of these hills are barren. The areas that border Rajasthan's desert are home to sandy plains, where the vegetation is very regular and scarce. Only those drought resistant species constitute the permanent structural framework of vegetation. The natural vegetation survives only in a few pockets. The main vegetation of the area are *Balanites aegyptiaca*, *Cordia sinensis*, Prosopsis cineraria, *Salvadora oleoides*, *Tecomella undulata*, *Senegalia senegal*, *Terminalia pendula*, *Vachellia leucophloea*, *Clerodendrum phlomidis*, *Searsia mysorensis*, *Capparis decidua*, *Lycium barbarum*, *Gymnosporia emarginata*, *Grewia tenax*, *Commiphora wightii*, *Ziziphus nummularia* in tree and shrub layers while *Cissampelos pareira*, *Capparis zeylanica*, *Celastrus paniculatus*, *Leptadenia reticulata*, *Ichnocarpus frutescens*, *Cocculus hirsutus*, *Ephedra foliata* and *Tinospora cordifolia* in climbers.

**3.2. Shiwalik Ranges:** The elevation of these hills ranges from 600 to 1200 meters above sea level, and they span around 2400 kilometers with an average width of 20 to 24 kilometers. Numerous erosional landform features, including rills, gullies, scraps, differently shaped ridges, and amphitheater basins, have been created by weathering and denudation. Tropical dry deciduous forests with a profusion of prickly species are what define these hills. These ranges are distinguished by the following forest types:

i. Sal forests which is mainly confined in Kalesar National Park (KNP) and dominated with *Shorea robusta* as main species intermixed with *Mallotus philippensis*, *Mitragyna parvifolia*, *Ehretia laevis*, *Ficus* *semicordata*, *Adina cordifolia*, *Kydia calycina*, *Holarrhena pubescens*, *Schleichera oleosa*, *Ficus racemosa*, *Sterculia villosa*, *Terminalia alata* in tree layer, *Clerodendrum infortunatum*, *Justicia adhatoda*, *Helicteres isora*, *Carissa spinarum*, *Catunaregam spinosa*, *Woodfordia fruticosa* in shrub layer and *Phanera vahlii*, *Celastrus paniculatus* and *Millettia extensa* in climber layer.

ii. Chir forests are only confined in upper edges of Morni hills which consists of *Pinus roxburghii*, *Adina cordifolia*, *Pyrus pashia*, *Falconeria insignis*, *Pistacia chinensis* subsp. *integerrima* and *Quercus leucotrichophora* in tree layer, *Euphorbia royleana*, *Berberis lycium*, *B. asiatica*, *Rubus ellipticus* and *Rhus parviflora* in shrub layer while in climber layer *Clematis gauriana* and *Millettia extensa* are common.

**3.3. Miscellaneous forests:** Large tracts of land in the Kalesar Reserve Forest, Pinjore, and Morni Hills in the Shiwaliks are covered by diverse plants. The main species of these forests are: *Terminalia elliptica*, *Terminalia anogeissiana*, *Senegalia catechu*, *Boswellia serrata*, *Aegle marmelos*, *Senegalia modesta*, *Vachellia leucophloea*, *Adina cordifolia*, *Bauhinia racemosa*, *Buchanania lanzan*, *Casearia tomentosa*, *Bombax ceiba*, *Butea monosperma*, *Mitragyna parvifolia*, *Pachygone laurifolia*, *Cassia fistula*, *Dalbergia sisso*, *Ehretia laevis*, *Flacourtia jangomas*, *Ficus semicordata*, *F. palmata*, *F. auriculata*, *F. religiosa*, *F. benghalensis*, *Diospyros cordifolia*, *Kydia calycina*, *Holarrhena pubescens*, *Lannea coromandelica*, *Grewia optiva*, *Mallotus philippensis*, *Morus alba*, *Nyctanthes arbortristis*, *Pyrus pashia*, *Ougeiniao ojeinensis*, *Schleichera oleosa*, *Shorea robusta*, *Sterculia villosa*, *Syzygium cumini*, *Wendlandia heynei* etc., and *Prosopis juliflora* (planted but become naturalized in several forests), in tree layer. *Agave vivipara*, *Ipomea carnea*, *Justicia adhatoda*, *Barleria cristata*, *Helicteres isora*, *Carissa spinarum*, *Catunaregam spinosa*, *Strebulus asper*, *Lantana camara*, *Ziziphus nummularia*, *Rhus parviflora*, *Rubus ellipticus*, *Bergera koenigii*, and *Woodfordia fruticosa* in shrub layer. The climbers are comprising *Ziziphus oenoplia*, *Ipomea cairica*, *Vallaris solanacea*, *Ampelocissus latifolia*, *Cryptolepis buchanani*, *Jasminum multiflorum*, *Celastrus paniculatus*, *Pueraria tuberosa*, *Tinospora cordifolia*, *Capparis zeylanica* and *Cissampelos pareira* etc.

Aside from them, the vast majority of Haryana is covered with plains and its vegetation. In addition to native species, the Haryana plains are home to exotic plants cultivated through social forestry and other initiatives, as well as numerous other floristic aspects of the Indian subcontinent. The species of plains includes *Populus deltoides*, *Corymbia citriodora*, *Eucalyptus tereticornis*, *Eucalyptus camaldulensis*, *Eucalyptus paniculata*, *Fernandoa adenophylla*, *Tectona grandis*, *Dalbergia sissoo*, *Prosopis juliflora*, *Salvadora oleoides*, *Mangifera indica*, *Holoptelea integrifolia*, *Kigelia africana*, *Toona ciliata*, *Syzygium cuminii*, Terminalia arjuna, *Ailanthus excelsa*, *Ficus virens*, *F. racemosa*, *Grevillea robusta*, *Vachellia nilotica* subsp. *indica*, *Lagerstroemia speciosa*, *Terminalia bellirica* *Albizia lebbeck*, *Alstonia scholaris*, *Azadirachta indica*, Bombax ceiba, *Senegalia senegal*, *Spondias pinnata*, *Tamarix dioica*, *Melia azedarach*, *Neolamarckia cadamba*, *Phoenix sylvestris*, *Chukrasia tabularis*, *Dendrocalamus strictus*, *Mimusops elengi*, *Polyalthia longifolia*, *Leucaena leucocephala*, *Ricinus communis*, *Calotropis procera*, *Ziziphus nummularia* and *Dodonaea viscosa*.

| Table 1. Complete List of Ligneous Plant species of Haryana | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **S. No.** | **Plant Name** | **Vernacular Name** | **Family** | **Habit** | **Native/ Planted** | **Shiwalik Range** | **Aravalli Range** | **Plains** |
| 1. | *Abelmoschus moschatus* Medik. | Muskdana | Malvaceae | Shrub | Native | - | Gurugram, Rewari, Bhiwani, M. Garh | Ambala, Kaithal |
| 2. | *Abrus precatorius* L. | Ratti | Fabaceae | Climber | Native | Morni hills | M. Garh, Rewari, Bhiwani, Mewat, Gurugram | Ambala, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Sirsa, Yamuna Nagar |
| 3. | *Abutilon bidentatum* Hochst. | Dongara | Malvaceae | Shrub | Native | - | Gurugram, Rewari, Bhiwani, M. Garh | Rohtak, Jind |
| 4. | *Abutilon indicum* (L.) Sweet | Attibala, Kanghi | Malvaceae | Shrub | Native | KNP, Morni hills | Gurgaon, M. Garh, Mewat, Rewari, Faridabad, Bhiwani | Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, , Palwal, Panipat, Rohtak, Sirsa, Sonipat, |
| 5. | *Abutilon pannosum* (Forst.f.) Schlect | Attibala, Kanghi Buti | Malvaceae | Shrub | Native | KNP | M. Garh, Rewari, Bhiwani | - |
| 6. | *Abutilon ramosum* (Cav.) Guill. & Perr. | Kanghi | Malvaceae | Shrub | Native | - | - | Hisar |
| 7. | *Achyranthes aspera* L. | Latjira, Chitchita | Amaranthaceae | Shrub | Native | Common | Common | Common |
| 8. | *Adansonia digitata* L. | Gorakhimali | Bombacaceae | Tree | Planted | - | Gurugaon | - |
| 9. | *Adenanthera microsperma* Teijsmann & Binnendijk | Badi Gumachi, Rakat Chandan | Fabaceae | Tree | Planted | - | - | Ambala, Gurgaon, Kurukshetra, Yamuna Nagar |
| 10. | *Adina cordifolia* (Roxb.) Brandis | Haldu | Rubiaceae | Tree | Native | KNP, Morni hills | - | - |
| 11. | *Aegle marmelos* (L.) Correa | Bel | Rutaceae | Tree | Native | Common | Common | Common |
| 12. | *Aerva javanica* (Burm.f.) Juss. ex Schult. | Bui, Dholi | Amaranthaceae | Shrub | Native | KNP, Morni hills | - | - |
| 13. | *Agathis robusta* (C. Moore ex F. Muell.) F.M. Bailey | Agathis | Araucariaceae | Tree | Planted | Morni hills | - | - |
| 14. | *Agave vivipara*L. (syn. *Agave cantula* Roxb. ) | Ram Baans | Asparagaceae | Shrub | Planted (Naturalized) | KNP, Morni hills | - | - |
| 15. | *Ailanthus excelsa* Roxb. | Mahaneem, Motio Neem, Oollu Neem | Simaroubaceae | Tree | Planted | Common | Common | Common |

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| 16. | *Albizia chinensis* (Osbeck) Merr. | Siran | Fabaceae | Tree | Native | KNP, Morni hills | - | - |
| 17. | *Albizia lebbeck* (L.) Benth. | Siran, Kala Siris | Fabaceae | Tree | Native | KNP, Morni hills | Faridabad, Gurgaon, M. Garh, Mewat | Almost all over the state |
| 18. | *Albizia odoratissima* (L.f.) Benth. | Kala Siris | Fabaceae | Tree | Native | Morni hills | - | - |
| 19. | *Albizia procera* (Roxb.) Benth. | Safed Siris | Fabaceae | Tree | Native | KNP, Morni hills | Bhiwani, Faridabad, Gurgaon, M. Garh, Mewat, Rewari | Almost all over the state |
| 20. | *Alhagi maurorum* Medik. | Jawasa, Bharbharra | Fabaceae | Shrub | Native | - | - | Hisar, Jhajjar, Jind, Karnal, Kurukshetra, Panipat, Rohtak, Ambala |
| 21. | *Alstonia scholaris* (L.) R. Br. | Sapatparni | Apocynaceae | Tree | Native | KNP, Morni hills | Bhiwani, Faridabad, Gurgaon, M. Garh, Mewat, Rewari | Almost all over the state |
| 22. | *Ampelocissus latifolia* (Roxb.) Planch. | Jangali Angur | Vitaceae | Climber | Native | Morni hills | - | - |
| 23. | *Annona squamosa* L. | Shareefa | Annonaceae | Tree | Planted | Common | Common | Common |
| 24. | *Antidesma acidum* Retz. | Amaliya Beri | Phyllanthaceae | Shrub | Native | KNP | - | - |
| 25. | *Antigonon leptopus* Hook. & Arn. | Anant Lata | Polygonaceae | Climber | Planted | Morni hills | - | Yamuna Nagar |
| 26. | *Ardisia solanacea* (Poir.) Roxb. | Bissi | Myrsinaceae | Shrub | Native | KNP, Morni hills | - | - |
| 27. | *Artabotrys hexapetalus* (L.f.) Bhandari | Harit Champa | Annonaceae | Tree | Planted | Morni | - | Gurgaon, Kurukshetra, |
| 28. | *Artocarpus heterophyllus* Lam. | Kathal | Moraceae | Tree | Planted | Common | Common | Common |
| 29. | *Artocarpus lacucha* Buch.-Ham. | Badhal | Moraceae | Tree | Native | Common | Common | Common |
| 30. | *Asclepias curassavica* L. | Kakatundi | Apocynaceae | Shrub | Invasive | Morni hills | - | Gurugram |

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|---|---|---|---|---|---|---|---|---|
| 31. | *Asparagus adscendens* Roxb. | SatawariSafed Mushali | Asparagaceae | Shrub | Native | KNP, Morni hills | - | - |
| 32. | *Asparagus racemosus* Willd. | Narkanto, Satawar | Asparagaceae | Shrub | Planted | Common | Common | Common |
| 33. | *Aspidopterys wallichii* Hook. f. | Jugtar | Malpighiaceae | Climber | Native | Morni hills | - | - |
| 34. | *Atriplex nummularia* Lindl. | Orach | Amaranthaceae | Shrub | Invasive | - | - | Hisar |
| 35. | *Averrhoa carambola* L. | Kamrakh | Oxalidaceae | Tree | Planted | Common | Common | Common |
| 36. | *Azadirachta indica* A Juss. | Neem | Meliaceae | Tree | Native | Common | Common | Common |
| 37. | *Balanites aegyptiaca* (L.) Delile | Huingota, Hingot, Hingori, Hingli | Zygophyllaceae | Tree | Native | - | Bhiwani, Faridabad, Gurgaon, M. Garh, Rewari | Karnal, Kurukshetra, Mewat, Palwal, Panipat |
| 38. | *Baliospermum montanum* (Willd.) Muell-Arg. | Jangali Jamalgota | Euphorbiaceae | Shrub | Native | KNP, Morni hills | - | - |
| 39. | *Bambusa bambos* (L.) Voss | Kata Baans | Poaceae | Shrub | Native | Common | Common | Common |
| 40. | *Barleria acanthoides* Vahl | Bajardanti, Chapari | Acanthaceae | Shrub | Native | - | Rewari | - |
| 41. | *Barleria cristata* L. | Niljhatti | Acanthaceae | Shrub | Native | KNP, Morni hills | Gurgaon, M. Garh, Mewat, Rewari, Faridabad, Bhiwani, | Almost all over the state |
| 42. | *Barleria prionitis* L. | Peela Baansa | Acanthaceae | Shrub | Native | - | Gurgaon, M. Garh, | Ambala,Kaithal |
| 43. | *Barringtonia acutangula* (L.) Gaertn. | Samudriphal | Lecythidaceae | Tree | Planted | Morni hills | - | Kurukshetra |
| 44. | *Bauhinia purpurea* L. | *Gairal, Kachnari* | Fabaceae | Tree | Native | Common | Common | Common |
| 45. | *Bauhinia racemosa* Lam. | Jhinja, Kachnari, Asundro | Fabaceae | Tree | Native | KNP, Morni hills | Rewari, Gurugram | - |
| 46. | *Bauhinia variegata* L. | Kachnar, Papri | Fabaceae | Tree | Native | Common | Common | Common |
| 47. | *Beaucarnea* | Elephant | Asapargaceae | Tree | Planted | - | Gurugram | Rohtak, Sonipat |

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| | *recurvata*(K.Koch and Fintelm.) Lem. | Foot | | | | | | |
| 48. | *Berberis asiatica* Roxb. ex DC. | Kilmora | Berberidaceae | Shrub | Native | Morni hills | Pinjor (Panchkula) | - |
| 49. | *Berberis lycium* Royle | Kasmodo, Kilmora | Berberidaceae | Shrub | Native | Morni hills | - | - |
| 50. | *Bergera koenigii* L. [*Murraya koenigii* (L.) Spreng.] | *Gandela, Gani, Mithi Neem* | Rutaceae | Shrub | Native | Common | Common | Common |
| 51. | *Biancaea decapetala* (Roth) O.Deg. | Kingan, Allai | Fabaceae | Climbing Shrub | Native | Morni hills | - | - |
| 52. | *Bischofia javanica* Blume | Paniyala | Phyllanthaceae | Tree | Native | KNP | - | - |
| 53. | *Bixa orellana* L. | Sindoori, Latkan | Bixaceae | Shrub | Planted | Morni hills | - | - |
| 54. | *Boehmeria macrophylla* Horn em. | Badasiyaru | Urticaceae | Shrub | Native | Morni hills | - | - |
| 55. | *Bombax ceiba* L. | Semal, Sembal | Bombacaceae | Tree | Native | Common | Common | Common |
| 56. | *Borassus flabellifer* L. | Tai | Arecaceae | Tree | Planted | Common | Common | Common |
| 57. | *Boswellia serrata* Roxb. ex Colebr. | Salar, Salai | Burseraceae | Tree | Native | KNP, Morni hills | M. Garh, Mewat, Rewari | |
| 58. | *Bougainvillea spectabilis* Willd. | Buganbail, Boganwallia | Nyctaginaceae | Shrub | Planted | Common | Common | Common |
| 59. | *Breynia vitis-idaea* (Burm.f.) C.E.C.Fisch. | Kamuni | Phyllanthaceae | Shrub | Native | Common | Common | Common |
| 60. | *Bridelia retusa* (L.) A.Juss. | Kajhi | Phyllanthaceae | Tree | Native | KNP, Morni hills | - | Ambala, Kurukshetra |
| 61. | *Broussonetia papyrifera* (L.) L'Hér. ex Vent. | Jangali Tut | Moraceae | Tree | Planted (Naturalized) | KNP, Morni hills | - | Ambala, Kurukshetra, Yamuna Nagar |
| 62. | *Buchanania lanzan* Spreng. | Chiraunji | Anacardiaceae | Tree | Native | KNP | - | |
| 63. | *Buddleja asiatica* Lour. | Neemda | Scrophulariaceae | Tree | Native | KNP, Morni hills | - | |
| 64. | *Butea monosperma* (Lam.) Taub. | Palash, Dhaak | Fabaceae | Tree | Native | Common | Common | Common |

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| 65. | *Caesalpinia pulcherrima* (L.) Sw. | Guletera, Gulmohari | Fabaceae | Shrub | Planted | Common | Common | Common |
| 66. | *Cajanus scarabaeoides* (L.) Thouars | Bankultha | Fabaceae | Climber | Native | Morni hills | - | Ambala, Karnal, Yamuna Nagar |
| 67. | *Calliandra haematocephala* Hassk. | Bijauri | Fabaceae | Shrub | Planted | Common | Common | Common |
| 68. | *Callicarpa macrophylla* Vahl. | Daiya | Lamiaceae | Shrub | Native | KNP, Morni hills | - | Ambala |
| 69. | *Calotropis gigantea* (L.) Dryand. | Aak, Moto-Aak | Apocynaceae | Shrub | Native | Common | Common | Common |
| 70. | *Calotropis procera* (Aiton) Dryand. | Aak, Akaro | Apocynaceae | Shrub | Native | Common | Common | Common |
| 71. | *Campylotropis stenocarpa* (Klotzsch) Schindler | Harvstki | Fabaceae | Shrub | Native | KNP, Morni hills | - | - |
| 72. | *Canavalia gladiata* (Jacq.) DC. | Talwar Sem | Fabaceae | Climber | Planted | KNP | - | - |
| 73. | *Capparis decidua* (Forssk.) Edgew. | Hins | Capparaceae | Shrub | Native | - | Bhiwani, Faridabad, M. Garh, Mewat, Gurgram, Rewari, | Almost all over the state |
| 74. | *Capparis sepiaria* L. | Kil, Kanthari | Capparaceae | Shrub | Native | - | - | Almost all over the state |
| 75. | *Capparis zeylanica* L. | Hins | Capparaceae | Climbin g Shrub | Native | KNP, Morni-Pinjore, | Bhiwani, Faridabad, Gurgram, M. Garh, Mewat, | Almost all over the state |
| 76. | *Cardiospermum halicacabum* L. | Kanphuti, Kakadni, Kapal Phori | Sapindaceae | Climber | Native | Common | Common | Common |
| 77. | *Careya arborea* Roxb. | Kumbhi | Lecythidaceae | Tree | Native | KNP | - | - |
| 78. | *Carissa spinarum* L. | Jangali Karaunda | Apocynaceae | Shrub | Native | Common | Common | Common |
| 79. | *Carissa carandas* L. | Karaunda | Apocynaceae | Shrub | Planted | - | - | Hisar, Jind, Karnal, Kurukshetra, Panipat, Rohtak, |

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| | | | | | | | | Sonepat, Yamuna Nagar, Gurugram |
| 80. | *Caroxylon imbricatum var. imbricatum* [syn. *Salsola baryosma* (Roem. & Schult.) Dandy] | Lani | Amaranthaceae | Shrub | Native | - | Rewari, Mewat | Hissar, Jhajjhar |
| 81. | *Carthamus tinctorius* L. | Kusum | Asteraceae | Shrub | Planted | - | - | Yamuna Nagar |
| 82. | *Caryota urens* L. | Mari, Fishtail Palm | Arecaceae | Tree | Planted | Common | Common | Common |
| 83. | *Cascabela thevetia* (L.) Lippold [syn.*Thevetia neriifolia* (J)& Stead] | Pilikaner | Apocynaceae | Small Tree | Planted | Common | Common | Common |
| 84. | *Casearia graveolens* Dalzell | Chilla | Salicaceae | Tree | Native | Morni-Pinjore | - | Ambala, Kurukshetra, Yamuna Nagar |
| 85. | *Casearia tomentosa* Roxb. | Chilla | Salicaceae | Tree | Native | KNP, Morni-Pinjore | - | Ambala, Yamuna Nagar |
| 86. | *Cassia fistula* L. | Amaltash | Fabaceae | Tree | Native | Common | Common | Common |
| 87. | *Cassia javanica* subsp. *nodosa* (Buch.-Ham. ex Roxb.) | Java Cassia | Fabaceae | Tree | Planted | - | Gurugram, Bhiwani, | Yamuna Nagar |
| 88. | *Cassine albens* (Retz.) Kosterm. | - | Celastraceae | Tree | Native | Morni hills | - | - |
| 89. | *Cassine glauca* (Rottb.) Kuntze | Jamrasi | Celastraceae | Tree | Native | KNP, Morni hills | - | - |
| 90. | *Casuarina equisetifolia* L. | Jangali Saru | Casuarinaceae | Tree | Planted | Common | Common | Common |
| 91. | *Catamixis baccharoides* Thomson | Catamisix | Asteraceae | Shrub | Native | KNP | - | - |
| 92. | *Catunaregam spinosa* (Thunb.) Tirveng. | Kari | Rubiaceae | Tree | Native | KNP, Morni-Pinjore | - | Ambala, Kurukshetra, Rohtak, Sonipat, Yamuna Nagar |

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| 93. | *Cayratia trifolia* (L.) Domin | Amalbail | Vitaceae | Climber | Native | Common | Common | Common |
| 94. | *Cebatha pendula* (J.R.Forst. & G.Forst.) Kuntze (Syn. *Cocculus pendulus* (J.R.Forst. & G.Forst.) Diels) | Poh | Menispermaceae | Climber | Native | | Rewari, Mewat, Gurugram, Bhiwani, M.Garh | Jind, Sonipat, Rohatak |
| 95. | *Ceiba speciosa* (A. St.-Hil.) Ravenna | Reshamrui | Bombacaceae | Tree | Planted | Common | Common | Common |
| 96. | *Celastrus paniculata* Willd. | Malkangani | Celastraceae | Climber | Native | KNP, Morni-Pinjore | - | - |
| 97. | *Celosia argentea* L. | Sarvali | Amaranthaceae | Shrub | Native | Morni hills | - | Ambala |
| 98. | *Celtis tetrandra* Roxb. | Khadik | Ulmaceae | Tree | Native | KNP, Morni-Pinjore, | - | Ambala, Yamuna Nagar |
| 99. | *Cestrum parqui* (Lam.) L'Hér. | Raat Ki Rani | Solanaceae | Shrub | Planted | Common | Common | Common |
| 100. | *Cestrum nocturnum* L. | Raat Ki Rani | Solanaceae | Shrub | Planted | Common | Common | Common |
| 101. | *Chukrasia tabularis* A.Juss. | Chukrasia | Meliaceae | Tree | Planted | Common | Common | Common |
| 102. | *Cissampelos pareira* L. | Jaljamani | Menispermaceae | Climber | Native | KNP, Morni hills | - | Ambala, Yamuna Nagar, Kurushetra, Kaithal |
| 103. | *Cissus quadrangularis* L. | Hadjod | Vitaceae | Climber | Planted | Morni-Pinjor | - | Yamuna Nagar |
| 104. | *Cissus repanda* Vahl | | Vitaceae | Climber | Native | KNP, Morni hills | - | - |
| 105. | *Citrullus colocynthis* (L.) Schrad. | Indarayan | Cucurbitaceae | Climber | Native | KNP | - | - |
| 106. | *Citrus aurantiifolia* (Christm.) Swingle | Kagji Nimbu | Rutaceae | Tree | Planted | Common | Common | Common |
| 107. | *Citrus aurantium* L. | Khatta santara | Rutaceae | Tree | Planted | Common | Common | Common |
| 108. | *Citrus limon* (L.) Osbeck. | Galgal | Rutaceae | Shrub | Planted | Common | Common | Common |

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| 109. | *Citrus maxima* (Burm.) Merr. | Chakotara | Rutaceae | Tree | Planted | Common | Common | Common |
| 110. | *Citrus medica* L. | Bada Nimbu | Rutaceae | Tree | Planted | Common | Common | Common |
| 111. | *Clematis buchananiana* DC. | Alka Loga | Ranunculaceae | Climber | Native | Morni hills | - | - |
| 112. | *Clematis gouriana* Roxb. ex DC. | Churanhaar | Ranunculaceae | Climber | Native | KNP, Morni hills | - | - |
| 113. | *Clematis roylei* Rehder | Nakchikani | Ranunculaceae | Climber | Native | Morni hills | - | - |
| 114. | *Cleome viscosa* L. | Hulhul | Cleomaceae | Shrub | Native | Morni hills | - | Ambala, Kurushetra, Kaithal, |
| 115. | *Clerodendrum chinense* (Osb eck) Mabb. | Chinese Glory | Lamiaceae | Shrub | Native | Morni - Pinjor | Gurugram, Rohtak | Ambala, Kurushetra |
| 116. | *Clerodendrum indicum* (L.) Kuntze | Barang | Lamiaceae | Shrub | Native | Morni hills | - | - |
| 117. | *Clerodendrum infortunatum* L . (syn. *Clerodendrum viscosum* Vent.) | BHaat | Lamiaceae | Shrub | Native | KNP, Morni hills | - | Ambala, Kurushetra, Kaithal |
| 118. | *Clerodendrum phlomidis* L.f. | Arana | Lamiaceae | Shrub | Native | - | Rewari, Mewat, Gurugram, Bhiwani, M.Garh | Rohtak, Jind, Jhajjar, Sonipat, Panipat |
| 119. | *Clitoria ternatea*L. | Aprajita, Koyalaali | Fabaceae | Climber | Planted (Naturalized) | Common | Common | Common |
| 120. | *Coccinia grandis* (L.) Voigt | Hangali Kudaru | Cucurbitaceae | Climber | Native | Common | Common | Common |
| 121. | *Cocculus hirsutus* (L.) W.Theob. | Phareed Booti | Menispermaceae | Climber | Native | Common | Common | Common |
| 122. | *Codariocalyx motorius* (Houtt.) H.Ohashi [syn.*Desmodium gyrans* (L.f.) DC] | Dudali | Fabaceae | Shrub | Native | Morni hills | - | Ambala, Yamuna Nagar |
| 123. | *Colebrookea oppositifolia* Sm. | Binda, Pasara | Lamiaceae | Shrub | Native | KNP, Morni hills | - | Ambala, Yamuna Nagar |

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| 124. | *Combretum indicum* (L.) DeFilipps | Madhumalti | Combretaceae | Climber | Native | Common | Common | Common |
| 125. | *Commiphora wightii* (Arn.) Bhandari | Guggal | Burseraceae | Shrub | Native | - | M.Garg, Rewari, Bhiwani, Mewat | - |
| 126. | *Conocarpus lancifolius* Engl. | Buttan wood | Combretaceae | Shrub | Planted | - | Gurugram | - |
| 127. | *Corchorus aestuans* L. | Choch, Hade ka khet, Kaga-roti | Malvaceae | Shrub | Native | Common | Common | Common |
| 128. | *Corchorus capsularis*L. | Harrana | Malvaceae | Shrub | Native | | Mewat, Rewari | |
| 129. | *Cordia dichotoma* G.Forst. | Lasoda | Boraginaceae | Tree | Native | Common | Common | Common |
| 130. | *Cordia sinensis* Lam. | Gundi | Boraginaceae | Tree | Native | | M.Garg, Rewari, Bhiwani, Mewat | - |
| 131. | *Cordia vestita* Hook.f. & Thom. | Kum | Boraginaceae | Tree | Native | KNP | - | - |
| 132. | *Cordia macleodii* Hook.f. &Thomson | Badalsoda | Boraginaceae | Tree | Native | KNP | - | - |
| 133. | *Corymbia citriodora* (Hook) K.D.Hill & L.A.S.Johnson (syn. *Eucalyptus citriodora* Hook.) | Safeda | Myrtaceae | Tree | Planted | Common | Common | Common |
| 134. | *Crateva magna* (Lour.) DC. (*Crateva nurvala* Buch.-Ham.) | Baruna | Capparaceae | Tree | Native | Morni – Pinjor | - | Ambala |
| 135. | *Crateva adansonii* DC. | Barun, Barni, Barna | Capparaceae | Tree | Native | KNP, Morni –Pinjor | - | Ambala, Kurukshetra |
| 136. | *Crotalaria burhia* Buch.-Ham. | Shanio, Sanni, Kharsana | Fabaceae | Shrub | Native | - | Rewari, M.Garh, Gurugram | Hisar |
| 137. | *Crotalaria medicaginea* Lam. | Ashudhisha ag | Fabaceae | Shrub | Native | - | Rewari, M.Garh, Gurugram | - |
| 138. | *Crotalaria sericea* Burm.f. | Jhunjhuniya | Fabaceae | Shrub | Native | Morni hills | - | - |
| 139. | *Crotalaria spectabilis* Roth | Ghungari | Fabaceae | Shrub | Native | KNP | - | - |

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| 140. | *Croton bonplandianus* Ball. | Jamalgota | Euphorbiaceae | Shrub | Native | Common | Common | Common |
| 141. | *Cryptolepis buchananii* R.Br. ex Roem. & Schult. [syn.*Cryptolepis dubia* (Burm.f.) M.R.Almeida ] | Dudhi | Apocynaceae | Climber | Native | KNP, Morni –Pinjor | - | - |
| 142. | *Cucumis maderaspatanus* L. | Agnaki, Agumaki | Cucurbitaceae | Climber | Native | KNP | - | - |
| 143. | *Dalbergia sissoo* DC. | Shisham | Fabaceae | Tree | Native | Common | Common | Common |
| 144. | *Dalbergia lanceolaria* L.f. | Takauli | Fabaceae | Tree | Native | Morni hills | - | Ambala |
| 145. | *Datura stramonium*L. | Safed dathura | Solanaceae | Shrub | Native | Common | Common | Common |
| 146. | *Debregeasia saeneb* (Forssk.) Hepper & J.R.I.Wood | Sandoori, | Urticaceae | Shrub | Native | Morni hills | - | - |
| 147. | *Delonix regia* (Hook.) Raf. | Gulmohar | Fabaceae | Tree | Planted | Common | Common | Common |
| 148. | *Dendrocalamus hamiltonii* Nees & Arn. Ex Munro | Tama | Poaceae | Shrub | Planted | - | - | Kaithal (Sarswati WS) |
| 149. | *Dendrocalamus strictus* (Roxb.) Nees | Lathi baans | Poaceae | Shrub | Native | Common | Common | Common |
| 150. | *Dendrophthoe falcata* (L.f.) Ettings (syn. *Loranthus falcatus* L.f.) | Banda | Loranthaceae | Shrub | Native | Common | Common | Common |
| 151. | *Dichrostachys cinerea* (L.) Wight & Arn. | Sami | Fabaceae | Tree | Native | Common | Common | Common |
| 152. | *Dicoma tomentosa*Cass. | Vajardanti, Ubio til-kant | Asteraceae | Shrub | Native | - | Rewari, Mewat | - |
| 153. | *Dillenia indica* L. | Chalta | Dilleniaceae | Tree | Planted | Morni-Pinjore | Gurugram | - |
| 154. | *Dioscorea belophylla* (Prain) Voigt ex Haines | Ratalu | Dioscoreaceae | Climber | Native | Morni-Pinjore, | - | Yamuna Nagar, Ambala, |

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| | | | | | | KNP | | Kurukshetra |
| 155. | *Dioscorea bulbifera* L. | Ratalu | Dioscoreaceae | Climber | Native | Morni-Pinjore, KNP | - | Ambala, Karnal, Kaithal, Yamuna Nagar |
| 156. | *Dioscorea pentaphylla L.* | Pach Patia Alu | Dioscoreaceae | Climber | Native | KNP | - | |
| 157. | *Diospyros malabarica* (Desr.) Kostel | Guab | Ebenaceae | Tree | Native | Morni-Pinjore, | - | - |
| 158. | *Diospyros melanoxylon* Roxb. | Tendu | Ebenaceae | Tree | Native | KNP | - | - |
| 159. | *Diospyros montana* Roxb. | Vishtendu | Ebenaceae | Tree | Native | KNP, Morni-Pinjore | - | Ambala |
| 160. | *Diplocyclos palmatus* (L.) C.Jeffrey | Shivlangi | Cucurbitaceae | Climber | Native | Common | Common | Common |
| 161. | *Distimake aegyptius* (L.) A.R.Simões & Staples [*Merremia ageyptia* (L.) Urb.] | Khunti | Convolvulaceae | Climber | Invasive | Morni | - | Ambala, Yamuna Nagar |
| 162. | *Dodonaea viscosa* (L.) Jacq. | Vilayati , Aliyar | Sapindaceae | Shrub | Planted (Naturalized) | Morni-Pinjore | M.Garg, Gurugaon, Rewari, Bhiwani | |
| 163. | *Dombeya burgessiae* Gerrard ex Harv. & Sond. | Dobein | Malvaceae | Shrub | Planted | Common | Common | Common |
| 164. | *Duhaldea cappa* (Buch.-Ham. ex D. Don) Pruski & Anderb. | Gathihar | Asteraceae | Shrub | Native | KNP, Morni-Pinjore | - | Yamuna Nagar, Ambala |
| 165. | *Duranta erecta* L. | Duranta | Verbenaceae | Shrub | Planted | Common | Common | Common |
| 166. | *Ehretia laevis* Roxb. | Chmror, Desi papadi | Boraginaceae | Tree | Native | KNP, Morni-Pinjore | - | Yamuna Nagar, Ambala, Kaithal |
| 167. | *Ehretia acuminata* R.Br. | Punyan, Puna | Boraginaceae | Tree | Native | Morni Hills | - | - |
| 168. | *Engelhardtia spicata* Lechen ex Blume | Gadhmau, Mahava, Samm | Juglandaceae | Tree | Native | Morni Hills | - | - |

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| 169. | *Ephedra ciliata* Fisch. & C.A.Mey. (syn. *Ephedra foliata* Boiss. ex C.A.Mey. | Ootphog | Ephedraceae | Climber | Native | - | M.Garh, Bhiwani, Rewari | - |
| 170. | *Eranthemum pulchellum* An drews | Gulshaam | Acanthaceae | Shrub | Native | KNP, Morni hills | - | - |
| 171. | *Eriobotrya japonica* (Thunb.) Lindl. | Lokat | Rosaceae | Tree | Planted | Common | Common | Common |
| 172. | *Erythrina suberosa* Roxb. | Dhauladhak | Fabaceae | Tree | Native | KNP, Morni Hills | - | Ambala |
| 173. | *Erythrina variegata* L. | Pangara | Fabaceae | Tree | Planted | Common | Common | Common |
| 174. | *Eucalyptus tereticornis* Sm. | Safreda, Eucalyptus | Myrtaceae | Tree | Planted | Common | Common | Common |
| 175. | *Eucalyptus camaldulensis* D ehnh. | Safeda | Myrtaceae | Tree | Planted | Common | Common | Common |
| 176. | *Eucalyptus paniculata* Sm. | Bhura Eucalyptus | Myrtaceae | Tree | Planted | Common | Common | Common |
| 177. | *Euphorbia caducifolia* Haines. | Thor, Danda Thor | Euphorbiaceae | Shrub | Native | - | Rewari, Gurugram | - |
| 178. | *Euphorbia neriifolia* L. | Thuhar | Euphorbiaceae | Shrub | Native | - | | |
| 179. | *Euphorbia pulcherrima* Willd. ex Klotzsch | Llapati | Euphorbiaceae | Shrub | Planted | Common | Common | Common |
| 180. | *Euphorbia royleana* Boissier in DC. | Thok, Surai | Euphorbiaceae | Shrub | Native | KNP, Morni hills | - | - |
| 181. | *Falconeria insignis* Royle [*Sapium insigne* (Royle) Benth. ex Trimen] | Khinna, Kharun | Euphorbiaceae | Tree | Native | Morni Hills | - | - |
| 182. | *Fernandoa adenophylla* (Wall . ex G. Don) Steenis [syn. *Haplophragma adenophyllum* (Wall. ex G.Don) Dop] | Marodphali | Bignoniaceae | Tree | Planted | KNP, Morni Hills | Gurugram | Ambala, Yamuna Nagar, Kaithal |
| 183. | *Ficus auriculata* Lour. | Timla | Moraceae | Tree | Native | KNP, Morni Hills | - | Ambala, Yamuna Nagar |

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| 184. | *Ficus benghalensis* L. | Bargad, Badh, Barlo, Bar. | Moraceae | Tree | Native | Common | Common | Common |
| 185. | *Ficus benjamina* L. | Pukar | Moraceae | Tree | Planted (Naturalized) | Common | Common | Common |
| 186. | *Ficus elastica* Roxb. ex Hornem. | Rubber Plant | Moraceae | Tree | Planted (Naturalized) | Common | Common | Common |
| 187. | *Ficus hispida* L.f. | Daduri | Moraceae | Tree | Native | Common | Common | Common |
| 188. | *Ficus mollis* Vahl | Ban Peepal | Moraceae | Tree | Native | - | Common | Common |
| 189. | *Ficus palmata* Forssk. subsp. *virgata* (Roxb.) Browicz | Jangali Anjeer | Moraceae | Tree | Native | Common | Common | Common |
| 190. | *Ficus racemosa* L. | Goolar | Moraceae | Tree | Native | Common | Common | Common |
| 191. | *Ficus religiosa* L. | Peepal | Moraceae | Tree | Native | Common | Common | Common |
| 192. | *Ficus semicordata* Buch.-Ham. ex Smith | Bhuigoola, Jhar phalli | Moraceae | Tree | Native | KNP, Morni Hills | - | - |
| 193. | *Ficus virens* Aiton | Pilkhna, Pilkan | Moraceae | Tree | Native | Common | Common (planted) | Common |
| 194. | *Ficus rumphii* Blume | Pilkhi, Gajan | Moraceae | Tree | Native | Common | - | Ambala, Yamuna Nagar |
| 195. | *Flacourtia indica* (Burm.f.) Merr. | Kandai, Paniyala | Salicaceae | Tree | Native | KNP, Morni Hills | - | Ambala, Yamuna Nagar |
| 196. | *Flacourtia jangomas* (Lour.) Raeusch. | Kangati, Paniyala | Salicaceae | Tree | Native | KNP, Morni Hills | - | Ambala, Yamuna Nagar |
| 197. | *Flemingia bracteata* (Roxb.) Wight | Kanphuta | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 198. | *Flemingia macrophylla* (Willd.) Prain ex Merrill | Badasolpan | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 199. | *Flemingia strobilifera* (L.) W.T.Aiton | Kanphula | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |

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| 200. | *Flueggea leucopyrus* Willd. | Patala, Ghat-bor | Phyllanthaceae | Shrub | Native | - | Bhiwani, Fatehabad, Gurgaon, M. Garh, Mewat, Rewari, | Rohtak, Sonipat, Palwal, |
| 201. | *Gardenia jasminoides* J. Ellis | Gulchand, Gandhraj | Rubiaceae | Shrub | Planted (Naturalize d) | Common | Common | Common |
| 202. | *Garuga pinnata* Roxb. | Kharpat | Burseraceae | Tree | Native | KNP | - | - |
| 203. | *Glochidion heyneanum* (Wig ht & Arn.) Wight | Kalikanth | Phyllanthaceae | Tree | Native | KNP, Morni Hills | - | - |
| 204. | *Gloriosa superba* L. | Kalhari | Colchicaceae | Climber | Native | KNP, Morni Hills | - | Ambala, Kaithal |
| 205. | *Glycyrrhiza glabra* L. | Mulathi | Fabaceae | Shrub | Planted | - | Bhiwani | Yamuna Nagar, Hissar, Karnal, Kaithal |
| 206. | *Gmelina arborea* Roxb. | Gamhar | Lamiaceae | Tree | Planted | Common | Common | Common |
| 207. | *Gossypium arboreum* L. | Kapas | Malvaceae | Shrub | Planted | Common | Common | Common |
| 208. | *Grevillea robusta* A.Cunn. ex R.Br. | Silver Oak | Proteaceae | Tree | Planted | Common | Common | Common |
| 209. | *Grewia abutilifolia* Vent. Ex. Juss. | Gangeti | Malvaceae | Shrub | Native | - | Rewari, Mewat | - |
| 210. | *Grewia asiatica* L. | Phalsa | Malvaceae | Tree | Native | Morni Hills | - | Ambala, Kurushetra, Yamuna Nagar |
| 211. | *Grewia optiva* J.R.Drumm. ex Burret | Bheemal, Bahal | Malvaceae | Tree | Native | KNP, Morni Hills | - | - |
| 212. | *Grewia tenax* (Forssk.) Fiori | Godani, Gundhni, Gangarun | Malvaceae | Shrub | Native | - | Mewat, M. Garh, Bhiwani, Gurugram, Rewari | - |
| 213. | *Grewia villosa* Wild. | Falsa | Malvaceae | Shrub | Native | - | M.Garh | - |
| 214. | *Grewia flavescens* Juss. | Panchnota, Godani | Malvaceae | Tree | Native | KNP | Mewat, M. Garh, Bhiwani, Gurugram, Rewari | - |

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| 215. | *Grewia hirsuta* Vahl. | Kakarandah, Cucarbeech Pahorangli | Malvaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 216. | *Grewia serrulata* DC. | Bhansuli | Malvaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 217. | *Grewia tiliifolia* Vahl | Phalsa | Malvaceae | Tree | Native | KNP, Morni Hills | - | - |
| 218. | *Guilandina bonduc*L. (syn. *Caesalpinia bonduc* (L.) Roxb.) | Kateli | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 219. | *Gymnosporia emarginata* (Willd.) Thwaites [*Maytenus emarginata* (Willd.) Ding Hou] | Talkar, Kakera | Celastraceae | Shrub | Native | Morni Hills | Mewat, M. Garh, Bhiwani, Gurugram, Rewari | - |
| 220. | *Hamelia patens* Jacq. | Firebush | Rubiaceae | Tree | Planted | Common | Common | Common |
| 221. | *Helicteres isora* L. | Marodphali | Malvaceae | Shrub | Native | KNP, Morni Hills | Faridabad, Gurgaon, Morni-Pinjore | Ambala, Yamuna Nagar, Kurukshetra, |
| 222. | *Helinus lanceolatus* Brandis | Murain | Rhamnaceae | Shrub | Native | KNP, Morni Hills | - | Yamuna Nagar |
| 223. | *Hemidesmus indicus* (L.) R. Br. ex Schult. | Anantmool | Apocynaceae | Climber | Native | KNP | - | - |
| 224. | *Hibiscus rosa-sinensis* L. | Gudhal | Malvaceae | Shrub | Planted | Common | Common | Common |
| 225. | *Hibiscus sabdariffa* L. | Lalsan | Malvaceae | Shrub | Planted | Common | Common | Common |
| 226. | *Hibiscus micranthus* L.f. | Okada | Malvaceae | Shrub | Planted | Morni hills | | Kaithal |
| 227. | *Hibiscus syriacus* L. | Gurhal | Malvaceae | Shrub | Planted | Common | Common | Common |
| 228. | *Hiptage benghalensis* (L.) Kurz | *Madhavilata* | Malpighiaceae | Climber | Native | Morni | - | - |
| 229. | *Holarrhena pubescens* (Buch.-Ham.) Wall. Ex G. Don (syn. *Holarrhena antidysenterica* | Doodhi, Kurchi | Apocynaceae | Tree | Native | KNP, Morni Hills | - | Yamuna Nagar, Ambala |

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| | Wall.) | | | | | | | |
| 230. | *Holoptelea integrifolia* Planch. | Kanju, Papri, Chilbil | Ulmaceae | Tree | Native | Common | Common | Common |
| 231. | *Hymenodictyon orixense* (Roxb.) Mabberley [*Hymenodictyon excelsum* (Roxb.) Wall.] | Badaru, Borang, Bhoolan | Rubiaceae | Tree | Native | KNP | - | Ambala |
| 232. | *Ichnocarpus frutescens* (L.) W.T. Alton | Kalidudhi | Apocynaceae | Climber | Native | KNP, Morni-Pinjore | - | Karnal, Kurukshetra, Panipat |
| 233. | *Indigofera atropurpurea* Buch.-Ham. ex Hornem | Saakhinu | Fabaceae | Shrub | Native | Morni Hills | - | - |
| 234. | *Indigofera cassioides* DC. | Neel Kathi | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 235. | *Indigofera oblongifolia* Forsk. | Goilia or Jhil. | Fabaceae | Shrub | Native | - | Mewat, Rewari | - |
| 236. | *Indigofera astragalina* DC. | Dagadiya | Fabaceae | Shrub | Native | Morni-Pinjore | - | Ambala, Hisar, Jhajjar, Jind, Karnal, Kurukshetra, Panipat, Rohtak, Yamuna Nagar |
| 237. | *Indigofera heterantha* Brandis | Shakina | Fabaceae | Shrub | Native | KNP, Morni Hills | - | - |
| 238. | *Ipomea muricata* (L.) Jacq. | Barik Bhovari | Convolvulaceae | Climber | Invasive | - | - | Ambala, Yamuna Nagar |
| 239. | *Ipomea pes-tigridis* L. | Panchpatia | Convolvulaceae | Climber | Invasive | KNP | | Ambala |
| 240. | *Ipomoea cairica* (L.) Sweet | Neelibel | Convolvulaceae | Climber | Planted (Naturalized) | Common | Common | Common |
| 241. | *Ipomoea carnea* subsp. *fistulosa* (Mart. ex Choisy) D.F. Austin | Besharma | Convolvulaceae | Shrub | Invasive | Common | Common | Common |
| 242. | *Ipomoea hederifolia*L. | Lal pungli | Convolvulaceae | Climber | Invasive | Morni Hills | | Ambala |
| 243. | *Ipomoea nil* (L.) Roth, C | Neelkalmi | Convolvulaceae | Climber | Invasive | KNP | - | - |
| 244. | *Ipomoea triloba* L. | Little Bell Morning | Convolvulaceae | Climber | Invasive | Morni Hills | | Yamuna Nagar, Kurushetra |

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| | | Glory | | | | | | |
| 245. | *Ixora coccinea* L. | Ixora, Kota Gandhal | Rubiaceae | Shrub | Planted | Common | Common | Common |
| 246. | *Jacaranda mimosifolia* D. Don | Neeli Gulmohar | Bignoniaceae | Tree | Planted | Common | Common | Common |
| 247. | *Jasminum arborescens* Roxb. | Chameli | Oleaceae | Shrub | Native | Morni Hills | - | Ambala, Yamuna Nagar, Sonipat |
| 248. | *Jasminum multiflorum* (Burm.f.) Andrews, Bot. | Chameli | Oleaceae | Shrub | Native | KNP | - | - |
| 249. | *Jasminum sambac* (L.) Aiton | Motiya, Mogara | Oleaceae | Shrub | Planted | Common | Common | Common |
| 250. | *Jasminum grandiflorum* L. | Chameli | Oleaceae | Climber | Native | Morni Hills | - | - |
| 251. | *Jasminum humile* L. | Peeli Chameli | Oleaceae | Shrub | Planted | Common | Common | Common |
| 252. | *Jatropha curcas* L. | Jangali Arand | Euphorbiaceae | Shrub | Planted | Common | Common | Common |
| 253. | *Jatropha gossypifolia* L. | Mayala, Ratanjyoti | Euphorbiaceae | Shrub | Native | KNP, Morni Hills | - | Ambala, Yamuna Nagar |
| 254. | *Justicia adhatoda* L.[ *Adhatoda adhatoda* (L.) Huth] | Basuti, Bansa | Acanthaceae | Shrub | Native | KNP, Morni hills | Common | Common |
| 255. | *Kigelia africana* (Lam.) Benth. | Balamkheer a | Bignoniaceae | Tree | Planted | Common | Common | Common |
| 256. | *Kydia calycina* Roxb. | Pathha, Pula | Malvaceae | Tree | Native | KNP, Morni Hills | - | - |
| 257. | *Lagerstroemia indica* L. | Sawani | Lythraceae | Tree | Planted | Common | Common | Common |
| 258. | *Lagerstroemia parviflora* Roxb. | Sidhh | Lythraceae | Tree | Native | KNP, Morni Hills | - | - |
| 259. | *Lagerstroemia speciosa* (L.) Pers. | Jarul | Lythraceae | Tree | Planted | Common | Common | Common |
| 260. | *Lannea coromandelica* (Houtt.) Merr. | Jhingan | Anacardiaceae | Tree | Native | KNP, Morni Hills | - | - |
| 261. | *Lantana camara* L. | Phooll Lakadi, Lantana | Verbenaceae | Shrub | Invasive | Common | Common | Common |

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| 262. | *Lawsonia inermis* L. | Mehandi | Lythraceae | Shrub | Planted | Common | Common | Common |
| 263. | *Leea asiatica* (L.) Ridsdale | Banchalita | Vitaceae | Shrub | Native | Morni Hills | - | - |
| 264. | *Leptadenia pyrotechnica* (Forssk.) Decne | Kheep, Khip | Apocynaceae | Climber | Native | | Faridabad, M. Garh, Mewat, Gurgram, Rewari, | Bhiwani, Fatehabad, Hisar, Jhajjar, Jind, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa |
| 265. | *Leptadenia reticulata* (Retz.) Wight | Jhumaka | Apocynaceae | Climber | Native | - | M. Garh, Mewat, Rewari | - |
| 266. | *Leptopus cordifolius* Decne. | Bhartoi | Phyllanthaceae | Shrub | Native | Morni Hills, KNP | - | Ambala |
| 267. | *Lespedeza juncea* var. *sericea* (Thunb.) Lace & Hauech | Tipatiya | Fabaceae | Shrub | Native | Morni Hills | - | - |
| 268. | *Leucaena leucocephala* (Lam.) de Wit | Safed Babool, Subabool, Vilayati Siris | Fabaceae | Tree | Planted | Common | Common | Common |
| 269. | *Leucomeris spectabilis* D.Do n | Phusyari | Asteraceae | Tree | Native | KNP | - | - |
| 270. | *Lippia alba* (Mill.) N.E.Br. ex Britton & P.Wilson | Ghneri | Verbenaceae | Shrub | Native | Morni Hills | M.Garh, Rewari | - |
| 271. | *Litchi chinensis* Sonn. | Litchi | Sapindaceae | Tree | Planted | Common | Common | Common |
| 272. | *Litsea glutinosa* (Lour.) C.B.Rob. | Maida | Lauraceae | Tree | Native | KNP | - | - |
| 273. | *Livistona chinensis* (Jacq.) R.Br. ex Mart. | China Palm | Arecaceae | Tree | Planted | Common | Common | Common |
| 274. | *Lycium barbarum* L. | Garothi | Solanaceae | Shrub | Native | - | - | Mewat, Rewari, Bhiwani |
| 275. | *Madhuca longifolia* J.F. Macbr. var. *latifolia* (Roxb.) A. Chev | Mahua | Sapotaceae | Tree | Native | KNP | - | Ambala |
| 276. | *Maerua oblongifolia* (Forssk. ) A.Rich. | Pilwani, Hemkand | Capparaceae | Climber | Native | - | Rewari, Gurgaon, M. Garh, Mewat | Bhiwani, Faridabad, Palwal, Panipat, Rohtak Karnal, |

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| 277. | *Magnolia champaca* (L.) Baill. ex Pierre | Champa | Magnoliaceae | Tree | Planted | Common | Common | Common |
| 278. | *Mallotus nudiflorus* (L.) Kulju & Welzen (syn. *Trewia nudiflora* L.) | Gutel | Euphorbiaceae | Tree | Native | - | - | Ambala, Kurukshetra |
| 279. | *Mallotus philippensis* (Lam.) Müll.Arg. | Rohani | Euphorbiaceae | Tree | Native | Morni-Pinjore, KNP | - | Ambala, Gurgaon, Kurukshetra, Yamuna Nagar |
| 280. | *Malvastrum coromandelianum* (L.) Garcke | Vangulav | Malvaceae | Shrub | Native | KNP | - | Ambala, Kurukshetra, Yamuna Nagar |
| 281. | *Mangifera indica* L. | Aam | Anacardiaceae | Tree | Native | Common | Common | Common |
| 282. | *Manilkara zapota* (L.) P.Royen | Chiku | Sapotaceae | Tree | Planted | Morni-Pinjor | Gurugram, Faridabad | Ambala, Yamuna Nagar |
| 283. | *Manilkara hexandra* (Roxb.) Dubard | Khirani | Sapotaceae | Tree | Planted | Morni-Pinjor | Gurugram | |
| 284. | *Maoutia puya* (Hook.) Wedd. | Sehra | Urticaceae | Shrub | Native | KNP, Morni Hills | - | Ambala |
| 285. | *Marsdenia roylei* Wight | Murawa | Apocynaceae | Climber | Native | Morni Hills | - | - |
| 286. | *Martynia annua* L. | Bichhu, Hathjodi | Martyniaceae | Shrub | Native | KNP, Morni Hills | | Ambala, Kurukshetra, Yamuna Nagar, Kaithal |
| 287. | *Melaleuca viminalis* (Sol. ex Gaertn.) Byrnes [syn. *Callistemon viminalis* (Sol. ex Gaertn.) G.Don] | Botalbrush | Myrtaceae | Tree | Planted | Common | Common | Common |
| 288. | *Melia azedarach* L. | Bakain, Dhrek | Meliaceae | Tree | Native | Common | Common | Common |
| 289. | *Melochia corchorifolia* L. | Bil Pat | Malvaceae | Shrub | Native | KNP, Morni Hills | | Ambala, Yamuna Nagar, Jind, Sonipat, Kaithal |
| 290. | *Merremia hederacea* (Burm.f) Hallier f. | Hemali | Convolvulaceae | Climber | Native | - | - | Ambala, Yamuna Nagar |

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| 291. | *Mesua ferrea* L. | Nagkehar | Clusiaceae | Tree | Planted | Morni-Pinjor | Gurugram | - |
| 292. | *Miliusa velutina* (A.DC.) Hook.f. & Thomson | Domsal | Annonaceae | Tree | Native | KNP | - | Ambala |
| 293. | *Millettia extensa* (Benth.) Baker in Hook. f. (syn. *Millettia auriculata* Baker) | Gaunj, Goj | Fabaceae | Climber | Native | KNP, Morni Hills | - | Ambala, Yamuna Nagar |
| 294. | *Millettia peguensis* Ali. | Tuma | Fabaceae | Tree | Planted | Morni-Pinjor | Gurugram, Faridabad | Ambala |
| 295. | *Millingtonia hortensis* L.f. | Neeli ChameliAk ashneem | Bignoniaceae | Tree | Planted | Morni-Pinjor | Gurugram | Ambala, Kaithal |
| 296. | *Mimosa rubicaulis* Lam. subsp. *himalayana* (Gamble) H. Ohashi | Aila, Hajeru (Macadam) | Fabaceae | Shrub | Native | KNP, Morni Hills | Rewari, Mewat | Ambala |
| 297. | *Mimosa pudica* L. | Chui-mui | Fabaceae | Shrub | Invasive | Common | Common | Common |
| 298. | *Mimusops elengi* L. | Maulshree | Sapotaceae | Tree | Planted | Morni-Pinjor | Gurugram, Rewari, Bhiwani | Ambala, Kaithal, Sonipat, Rohtak, Jind |
| 299. | *Mitragyna parvifolia* (Roxb.) Korth. | Kaim | Rubiaceae | Tree | Native | Morni-Pinjor | - | - |
| 300. | *Momordica dioica* Roxb. ex Willd. | Bankarela | Cucurbitaceae | Climber | Native | Morni-Pinjor | - | - |
| 301. | *Morinda pubescens* Sm. L. | Aal | Rubiaceae | Shrub | Native | KNP | - | - |
| 302. | *Morinda citrifolia* L. | Bartundi, Noni | Rubiaceae | Tree | Planted | Morni-Pinjor | - | - |
| 303. | *Moringa oleifera* Lam. | Sahjan, Sanjana | Moringaceae | Tree | Planted | Common | Common | Common |
| 304. | *Morus alba* L. | Shatut | Moraceae | Tree | Planted | Common | Common | Common |
| 305. | *Mucuna pruriens* (L.) DC | Kaunch | Fabaceae | Climber | Native | Common | Common | Common |
| 306. | *Mucuna nigricans* (Lour.) Steud. | Badi kaunch | Fabaceae | Climber | Native | Morni hills | - | Ambala |
| 307. | *Mukia maderaspatana* (L.) M. Roem. | Ankh-phod | Cucurbitaceae | Climber | Native | Common | Common | Common |

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| 308. | *Murraya paniculata* (L.) Jack | *Kamini* | Rutaceae | Shrub | Planted | Common | Common | Common |
| 309. | *Myrsine africana* L. | Chapra | Myrsinaceae | Shrub | Native | Morni hills | - | - |
| 310. | *Naringi crenulata* (Roxb.) D.H. Nicolson | Beli | Rutaceae | Shrub | Native | Morni hills, KNP | - | Ambala, Yamuna Nagar |
| 311. | *Neolamarckia cadamba* (Roxb.) Bosser | Cadamb | Rubiaceae | Tree | Planted | Common | Common | Common |
| 312. | *Nerium oleander* L. | Lal Kaner | Apocynaceae | Shrub | Native | Common | Common | Common |
| 313. | *Nicandra physalodes* (L.) Gaertn. | Ranpopati | Solanaceae | Shrub | Native | Morni hills, KNP | Bhiwani, Gurgram | Ambala, Kurukshetra, Panipat, Yamuna Nagar |
| 314. | *Nyctanthes arbortristis* L. | Harsingar, Parijat | Oleaceae | Tree | Native | Common | Common | Common |
| 315. | *Olax nana* Wall. ex Benth. | Sudiyo | Olacaceae | Shrub | Native | KNP | - | - |
| 316. | *Olea glandulifera* Wall. ex G. Don | Ger | Oleaceae | Tree | Native | KNP | - | - |
| 317. | *Olea paniculata* R.Br. | Indian Olive | Oleaceae | Tree | Native | Morni hills | - | - |
| 318. | *Opuntia dillenii* (Ker Gawl) Haw. | Nagphani | Cactaceae | Shrub | Native | - | Rewari, M.Garh, Mewat | Jind, Rohtak |
| 319. | *Opuntia elatior* Mill. | Nagphani | Cactaceae | Shrub | Native | Morni hills | - | - |
| 320. | *Oroxylum indicum* (L.) Vent. | Pharkat | Bignoniaceae | Tree | Native | Morni hills, KNP | - | Yamuna Nagar |
| 321. | *Osyris lanceolata* Hochst. & Steud. | Dalim | Santalaceae | Tree | Native | Morni hills | - | - |
| 322. | *Ototropis multiflora* (DC.) H.Ohashi & K.Ohashi [syn. *Desmodium multiflorum* DC.] | Multiflower Desmodium | Fabaceae | Shrub | Native | - | Morni | - |
| 323. | *Ougeinia oojeinensis* (Roxb.) Hochr. | Sandan | Fabaceae | Tree | Native | KNP, Morni-Pinjore | - | Ambala, Yamuna Nagar |
| 324. | *Oxystelma esculentum* (L. f.) Sm. | Doodhi ki beil | Apocynaceae | Climber | Native | - | - | Jind, Karnal, Kurukshetra, |

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| | | | | | | | | Panipat, Rohtak, Sonipat |
| 325. | *Pachygone laurifolia* (DC.) L.Lian & Wei Wang (Syn. *Cocculus laurifolius* DC.) | Marpinki | Menispermaceae | Tree | Native | KNP, Morni Hills | - | Ambala |
| 326. | *Parkinsonia aculeata* L. | Rambabool | Fabaceae | Shrub | Planted | Common | M. Garh, Mewat, Bhiwani, Faridabad, Gurugram, Rewari, | Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, , Panipat, Rohtak, Sirsa, Palwal |
| 327. | *Parthenocissus semicordata* ( Wall.) Planch. | Chappartan g | Vitaceae | Climber | Native | Morni hills | - | - |
| 328. | *Passiflora foetida* L. | Jhumuk Lata | Passifloraceae | Climber | Planted | KNP | | |
| 329. | *Passiflora suberosa* L. | Choti Jhumuk Lata | Passifloraceae | Climber | Native | KNP, Morni hills | - | Ambala, Kurukshetra, Yamuna Nagar |
| 330. | *Pavetta indica* L. | Kath Champa | Rubiaceae | Shrub | Native | Morni hills | - | - |
| 331. | *Pergularia daemia* (Forssk.) Chiov. | Gadariari Bel, Menda singi, Akadi | Apocynaceae | Climber | Native | - | - | Ambala, Hisar, Jhajjar, Jind, Karnal, Kurukshetra, Panipat, Rohtak |
| 332. | *Persicaria chinensis* (L.) H. Gross | Paral | Polygonaceae | Shrub | Native | Morni hills | - | - |
| 333. | *Phanera retusa* Benth. | Kandala, Semla | Fabaceae | Tree | Native | Morni hills | - | - |
| 334. | *Phanera vahlii* (Wight & Arn.) Benth.( *Bauhinia vahlii* Wight & Arn.) | Maljan | Fabaceae | Climber | Native | KNP, Morni hills | - | Ambala |
| 335. | *Phlogacanthus thyrsiformis* (Roxb. ex Hardw.) Mabb. | Nogamkak h | Acanthaceae | Shrub | Native | KNP, Morni hills | - | |
| 336. | *Phoenix loureiroi* Kunth [syn. *Phoenix humilis* (L.) Cav.] | Khajur | Arecaceae | Tree | Native | KNP, Morni-Pinjor | - | Yamuna Nagar, Ambala, Kurushetra, Kaithal |

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| 337. | *Phoenix acaulis* Roxb. | Khajuri | Arecaceae | Tree | Native | KNP | - | Ambala |
| 338. | *Phoenix sylvestris* (L.) Roxb. | Khajoor, Khajoorh | Arecaceae | Tree | Native | Morni-Pinjore | Bhiwani, Faridabad, Rewari, M. Garh, Gurggram, Mewat | Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Sonipat, Yamuna Nagar |
| 339. | *Phyllanthus emblica* L. | Amala, Anal | Phyllanthaceae | Tree | Native | Common | Common | Common |
| 340. | *Phyllanthus reticulatus* Poir. | Kale Madhu Ka Ped, Panjuli | Phyllanthaceae | Shrub | Native | Morni-Pinjore | - | Ambala, Karnal, Kurukshetra, |
| 341. | *Phyllodium pulchellum* (L.) Desv. | Thapi | Fabaceae | Shrub | Native | KNP, Morni hills | - | Ambala, Karnal |
| 342. | *Piliostigma malabaricum* (Roxb.) Benth. (syn. *Bauhinia malabarica* Roxb.) | Khatali | Fabaceae | Tree | Native | KNP | - | - |
| 343. | *Pinus roxburghii* Sarg. | Chir Pine | Pinaceae | Tree | Native | Morni hills | - | - |
| 344. | *Pistacia chinensis* subsp. *integerrima* (J.L.Stewart) Rech.f. | Kakdsinghi | Anacardiaceae | Tree | Native | Morni hills | - | - |
| 345. | *Pithecellobium dulce* (Roxb.) Benth. | Jangal Jalebi | Fabaceae | Tree | Planted | Common | Common | Common |
| 346. | *Pleurolobus gangeticus* (L.) J.St.-Hil. ex H.Ohashi & K.Ohashi [*Desmodium gangeticum* (L.) DC.] | Salparni | Fabaceae | Shrub | Native | KNP, Morni hills | - | Ambala, Yamuna Nagar |
| 347. | *Plumbago arabica* (Boiss.) Christenh. & Byng [*Dyerophytum indicum* (Gibson ex Wight) Kuntze] | Chit-tral | Plumbaginaceae | Shrub | Native | - | Mewat | - |
| 348. | *Plumbago zeylanica* Linn. | Chitrak | Plumbaginaceae | Shrub | Native | - | Common (Planted) | Common (Planted) |

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| 349. | *Plumeria rubra* L. | Golachin | Apocynaceae | Tree | Planted | Common | Common | Common |
| 350. | *Pogostemon benghalense* (Burm. f.) Kuntze | Jui Lata | Lamiaceae | Shrub | Native | KNP, Morni hills | - | Yamuna Nagar, Ambala |
| 351. | *Polhillides velutina* (Willd.) H.Ohashi & K.Ohashi [*Desmodium velutinum* (Willd.) DC.] | Motoi | Fabaceae | Shrub | Native | KNP, Morni hills | - | - |
| 352. | *Polyalthia longifolia* (Sonn.) Thwaites | Ashok | Annonaceae | Tree | Planted | Common | Common | Common |
| 353. | *Pongamia pinnata* (L.) Pierre | Karanj, Papri | Fabaceae | Tree | Planted | Common | Common | Common |
| 354. | *Populus deltoides* Marshall | Poplar | Salicaceae | Tree | Planted | Common | Common | Common |
| 355. | *Poranopsis paniculata* (Roxb.) Roberty | Safedbail | Convolvulaceae | Climber | Native | KNP, Morni hills | - | - |
| 356. | *Pouzolzia rugulosa* (Wedd.) Acharya & Kravtsova (syn. *Boehmeria rugulosa* Wedd). | Gethi, Gahita | Urticaceae | Tree | Native | Morni hills | - | - |
| 357. | *Premna barbata* Wall. ex Schauer | Bakaar | Lamiaceae | Tree | Native | KNP | - | - |
| 358. | *Premna latifolia* Roxb. | Bakar Basota | Lamiaceae | Tree | Native | KNP, Morni hills | - | - |
| 359. | *Prosopis juliflora* (Swartz) DC. | Maskat, Angreji bevanlio | Fabaceae | Tree | Planted (Naturalized) | Common | Common | Common |
| 360. | *Prosopis cineraria* (L.) Druce | Jhaand | Fabaceae | Tree | Native | - | Rewari, M. Garh, Bhiwani, Faridabad, Mewat, | Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Ambala |
| 361. | *Prunus persica* (L.) Stoke | Aadu | Rosaceae | Tree | Planted | Morni-Pinjore | Gurgram, Rewari, M. Garh, Mewat, | Ambala, Fatehabad, Hisar, Jhajjar, Jind, |

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| | | | | | | | Bhiwani, Faridabad, | Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Sonipat, Yamuna Nagar |
| 362. | *Prunus domestica* subsp. *insititia* (L.) Bonnier & Layens | Alucha, Alu Bukhara | Rosaceae | Tree | Planted | Morni hills | - | Ambala |
| 363. | *Pseudocaryopteris bicolor* (Roxb. ex Hardw.) P.D. Cantino | Ban basuti | Acanthaceae | Shrub | Native | Morni hills | - | - |
| 364. | *Psidium guajava* L. | Amrood | Myrtaceae | Tree | Planted | Common | Common | Common |
| 365. | *Psilanthus bengalensis* (Roxb. ex Schult.) J.-F.Leroy | Devmali | Rubiaceae | Shrub | Planted | KNP, Morni hills | - | - |
| 366. | *Pterospermum acerifolium* (L. ) Willd. | Kanak Champa | Malvaceae | Tree | Planted | - | - | Sonipat, Yamuna Nagar |
| 367. | *Pterygota alata* (Roxb.) R.Br. | Tula, Budha Coconut | Malvaceae | Tree | Planted | Morni hills | - | - |
| 368. | *Pueraria tuberosa* (Roxb. ex Willd.) Dc. | Vidarikand | Fabaceae | Climber | Native | Morni hills | - | - |
| 369. | *Punica granatum* L. | Annar | Lythraceae | Tree | Planted | Common | Common | Common |
| 370. | *Putranjiva roxburghii* Wall. | Jay Putra, Putrajeeva | Putranjivaceae | Tree | Native | KNP, Morni hills | - | Ambala, Yamuna Nagar, Karnal |
| 371. | *Pyracantha crenulata* (Roxb. ex D.Don) M.Roem. | Ghingaru | Rosaceae | Shrub | Native | Morni hills | - | - |
| 372. | *Pyrostegia venusta* (Ker Gawl.) | Sakrantbael | Bignoniaceae | Climber | Planted | Common | Common | Common |
| 373. | *Pyrus pashia* Buch. – Ham. ex D. Don | Mehal | Rosaceae | Tree | Native | KNP, Morni hills | Common | Ambala |
| 374. | *Quercus leucotrichophora* A. Camus | Banj Oak | Fagaceae | Tree | Native | Morni hills | - | - |
| 375. | *Randia tetrasprema* (Roxb.) | Bhedara | Rubiaceae | Tree | Native | KNP, Morni | - | Ambala |

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| | Benth., | | | | | hills | | |
| 376. | *Rauvolfia serpentina* (L.) Benth. ex Kurz | Sarpgandha | Apocynaceae | Shrub | Native | KNP | - | - |
| 377. | *Rhamnus triqueter* (Wall.) Lawson | Gaunt | Rhamnaceae | Tree | Native | KNP | - | - |
| 378. | *Rhynchosia minima* (L.) DC. | Kulthi, Kultah, Kalta, Chiri-motio, Kalta | Fabaceae | Climber | Native | KNP, Morni hills | - | Hisar |
| 379. | *Rhynchosia rothii* Benth. ex Aitchinson | Roth | Fabaceae | Climber | Native | Morni hills | - | - |
| 380. | *Ricinus communis* L. | Arandi | Euphorbiaceae | Shrub | Planted, Naturalized | Common | Common | Common |
| 381. | *Rivea ornata* (Roxb.) Choisy | - | Convolvulaceae | Climber | Native | KNP | - | - |
| 382. | *Rosa moschata* Herrmann | Kunja | Rosaceae | Climbin g Shrub | Native | Morni-Pinjore | - | - |
| 383. | *Roylea cinerea* (D.Don) Baill. | Titpatti | Lamiaceae | Shrub | Native | Morni-Pinjore | - | Ambala, Yamuna Nagar |
| 384. | *Roystonea regia* (Kunth) O.F.Cook | Bottal Palm | Arecaceae | Tree | Planted | Common | Common | Common |
| 385. | *Rubia manjith* Roxb. ex Fleming | Manjit | Rubiaceae | Climber | Native | KNP, Morni-Pinjore | | Ambala, Kurukshetra, Yamuna Nagar, Karnal, Kaithal |
| 386. | *Rubus ellipticus* Smith | Hisalu | Rosaceae | Shrub | Native | Morni-Pinjore | - | - |
| 387. | *Rubus niveus* Thunb. | Hazampet | Rosaceae | Shrub | Native | KNP, Morni-Pinjore | - | - |
| 388. | *Salix acmophylla* Boiss. | Bains Willow | Salicaceae | Tree | Native | Morni-Pinjore | - | - |
| 389. | *Salvadora oleoides* Decne. | Bada Peelu, Jal, Peelu, Kharo Jhal, | Salvadoraceae | Tree | Native | - | Bhiwani, Faridabad, Gurgram, Rewari, | Fatehabad, Hisar, Jind, Kaithal, Mewat, Palwal, |

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| | | | | | | | M. Garh, | Panipat, Rohtak, Sirsa, Sonipat |
| 390. | *Sapindus mukorossi* Gaertn. | Reetha | Sapindaceae | Tree | Planted | Common | Common | Common |
| 391. | *Sapindus emarginatus* Vahl | Reetha | Sapindaceae | Tree | Planted | Morni-Pinjore | - | - |
| 392. | *Saraca asoca* (Roxb.) Willd. | Sita ashok | Fabaceae | Tree | Planted | Common | Common | Common |
| 393. | *Schleichera oleosa* (Lour.) Oken | Kusum | Sapindaceae | Tree | Native | KNP | - | Ambala |
| 394. | *Scurrula cordifolia* (Wall.) G. Don | Jangali Banda | Loranthaceae | Shrub | Native | KNP, Morni-Pinjore | - | Ambala, Yamuna Nagar |
| 395. | *Scurrula pulverulenta* (Wall.) G. Don | Jangali Lata | Loranthaceae | Shrub | Native | KNP, Morni-Pinjore | - | - |
| 396. | *Searsia mysorensis* (G.Don) Moffett (syn. *Rhus mysorensis* G.Don. ) | Dasaro | Anacardiaceae | Shrub | Native | - | M. Garh, Mewat, Rewari | - |
| 397. | *Searsia parviflora* (Roxb.) F.A.Barkley (syn. *Rhus parviflora* Roxb.) | Tungala | Anacardiaceae | Shrub | Native | Morni-Pinjore | - | - |
| 398. | *Semecarpus anacardium* L. f. | Gheru, Bhilwa | Anacardiaceae | Tree | Native | KNP | - | Ambala |
| 399. | *Senegalia catechu* (L.f.) P.J.H. Hurter & Mabb. | Khair | Fabaceae | Tree | Native | Morni-Pinjore, KNP | - | Ambala, Jind, Karnal, Kurukshetra, Panipat, Yamuna Nagar |
| 400. | *Senegalia gageana* (Craib) Maslin, Seigler & Ebinger | Safed Khair | Fabaceae | Tree | Native | KNP | - | - |
| 401. | *Senegalia modesta* (Wall.) P.J.H.Hurter [syn. *Acacia modesta* Wall.] | Phalia, Phulai | Fabaceae | Tree | Native | Morni-Pinjore | - | Ambala, Hisar, Jhajjar, Jind, Karnal, Kurukshetra, Panipat, Rohtak, Yamuna Nagar |
| 402. | *Senegalia pennata* (L.) | Sahemabi, | Fabaceae | Climber | Native | KNP, Morni | Mewat | - |

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|---|---|---|---|---|---|---|---|---|
| | Maslin [*Acacia pennata* (L.) Willd.] | Aiala | | | | Hills | | |
| 403. | *Senegalia senegal* (L.) Britton [syn. *Acacia senegal* (L.) Willd.] | Kumbat, Kumatiyo | Fabaceae | Tree | Native | - | Rewari, Gurgram, Bhiwani, M. Garh, | Ambala, Faridabad, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mewat, Palwal, Panipat, Rohtak, Sirsa, Sonipat, |
| 404. | *Senegalia torta* (Roxb.) Maslin, Seigler & Ebinger (syn. *Acacia torta* (Roxb.) Craib.) | Khor | Fabaceae | Shrub | Native | - | Rewari, Gurgram, | - |
| 405. | *Senna didymobotrya* (Fresen.) H.S.Irwin & Barneby (syn. *Cassia didymobotrya* Fresen.) | Kala Adusa | Fabaceae | Shrub | Invasive | Morni – Pinjore | - | - |
| 406. | *Senna italica* Mill. | Chotatarad o | Fabaceae | Shrub | Invasive | - | M. Garh | - |
| 407. | *Senna occidentalis* (L.) Link (*Cassia occidentalis* L.) | Kasaunds, Kashudo | Fabaceae | Shrub | Invasive | Common | Common | Common |
| 408. | *Senna septemtrionalis* (Viviani) H. S. Irwin & Barneby (syn. *Cassia septemtrionalis* Viv.) | Senna | Fabaceae | Shrub | Invasive | Morni – Pinjore | - | - |
| 409. | *Senna siamea* (Lam.) H.S.Irwin & Barneby (syn. *Cassia siamea* Lam.) | Kasod | Fabaceae | Tree | Planted | Common | Common | Common |
| 410. | *Senna sulfurea* (Collad.) H.S.Irwin & Barneby (syn. *Cassia sulfurea* DC. ex Collad.) | Surat senna | Fabaceae | Tree | Planted | Common | Common | Common |
| 411. | *Senna tora* (L.) Roxb. | Panwar, Chakowar | Fabaceae | Shrub | Invasive | Common | Common | Common |
| 412. | *Senna auriculata* (L.) Roxb. | Awal, | Fabaceae | Shrub | Native | Morni – | - | - |

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| | | Tarwar | | | | Pinjore | | |
| 413. | *Sericostoma pauciflorum* Stocks ex Wight | Laggera | Boraginaceae | Shrub | Native | - | Bhiwani, M. Garh, Mewat, Rewari | Palwal, Rohtak |
| 414. | *Sesbania bispinosa* (Jacq.) W.Wight | Dhadhen | Fabaceae | Shrub | Native | | Gurugram | |
| 415. | *Sesbania sesban* (L.) Merr. | Ekad, Dhancha | Fabaceae | Shrub | Native | Common | Common | Common |
| 416. | *Shorea robusta* Roxb. ex Gaertner | Sal | Dipterocarpaceae | Tree | Native | Common (Natural) | Common (Planted) | Common (Planted) |
| 417. | *Shuteria involucrata* (Wall.) Wight & Arn | | Fabaceae | Climber | Native | Morni hills | - | Yamuna Nagar |
| 418. | *Sida acuta* Burm.f. | Bariara | Malvaceae | Shrub | Native | Common | Common | Common |
| 419. | *Sida cordifolia* L. | Balu, Kharenti | Malvaceae | Shrub | Native | Common | Common | Common |
| 420. | *Sida rhombifolia* L. | Attibala, Swetbala, Dulana | Malvaceae | Shrub | Native | Common | Common | Common |
| 421. | *Sida ovata* Forssk. | Bal, Dabi | Malvaceae | Shrub | Native | Common | Common | Common |
| 422. | *Smilax perfoliata* Lour. | | Smilacaceae | Climber | Native | KNP | - | - |
| 423. | *Smilax zeylanica* L. | Ramdatoon | Smilacaceae | Climber | Native | KNP, Morni Hills | - | - |
| 424. | *Soda stocksii* (Boiss.) Akhani [syn. *Haloxylon recurvum* (Moq.) Bunge ex Boiss.] | Khar | Amaranthaceae | Shrub | Native | - | - | Jhajjhar |
| 425. | *Solanum erianthum* D.Don | Ban Tambakhu | Solanaceae | Shrub | Native | Morni-Pinjore, KNP | - | Ambala, Yamuna Nagar |
| 426. | *Solanum incanum* L. | Dholi Ringni, Bhatkataiya | Solanaceae | Shrub | Native | KNP | - | - |
| 427. | *Solanum sisymbriifolium* Lam. | Swetrangani | Solanaceae | Shrub | Invasive | Morni-Pinjore, KNP | - | Ambala, Yamuna Nagar |

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| 428. | *Solanum torvum* Swartz. | Van Kataiya | Solanaceae | Shrub | Invasive | Morni-Pinjore, KNP | Mewat, Gurugram | - |
| 429. | *Solanum virginianum*L. (Syn. *S. surattense* Burm.f.) | Kateli | Solanaceae | Shrub | Native | KNP | - | - |
| 430. | *Solanum viarum* Dunal | Kataiya | Solanaceae | Shrub | Invasive | Morni-Pinjore, KNP | - | -- |
| 431. | *Solena amplexicaulis* (Lam.) Gandhi | Tarali | Cucurbitaceae | Climber | Native | KNP | - | - |
| 432. | *Solena heterophylla* Lour. | Ban Kakri | Cucurbitaceae | Climber | Native | KNP | - | - |
| 433. | *Spermadictyon suaveolens* Roxb. | Padera | Rubiaceae | Shrub | Native | KNP, Morni hills | - | - |
| 434. | *Spondias pinnata* (L. f.) Kurz | Amada | Anacardiaceae | Tree | Planted | Common | Common | Common |
| 435. | *Stephania glabra* (Roxb.) Miers | Pathbhed, Aaknadi | Menispermaceae | Climber | Native | KNP, Morni hills | - | - |
| 436. | *Stephanotis volubilis* (L.f.) S.Reuss, Liede & Meve [Syn. *Wattakaka volubilis* (L.f.) Stapf ] | Akadbel. Dangdodha i | Apocynaceae | Climber | Native | - | Bhiwani, Faridabad, Gurgaon, M. Garh, Mewat, Rewari | - |
| 437. | *Sterculia urens* Roxb. | Gulu, Karya, Katira | Malvaceae | Tree | Native | - | Mewat, Gurugram | - |
| 438. | *Sterculia villosa* Roxb. | Udal, Godhara | Malvaceae | Tree | Native | KNP, Morni hills | - | Ambala,Yamuna Nagar |
| 439. | *Stereospermum chelonoides* (L.f.) DC. | Padal | Bignoniaceae | Tree | Native | KNP, Morni hills | - | - |
| 440. | *Streblus asper* Lour. | Sihora | Moraceae | Shrub | Native | Morni - Pinjore | - | Ambala, Yamuna Nagar, Karnal, Kaithal |
| 441. | *Strobilanthes atropurpurea* Nees | Pale Trumpet Coneflower | Acanthaceae | Shrub | Native | KNP | - | - |
| 442. | *Strobilanthes auriculata* Nees | Eared Leaf Coneflower | Acanthaceae | Shrub | Native | Morni- | | |

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|---|---|---|---|---|---|---|---|---|
| | | | | | | Pinjore | | |
| 443. | *Strobilanthes wallichii* Nees | Pale Trumpet Coneflower | Acanthaceae | Shrub | Native | KNP | - | - |
| 444. | *Strychnos nux-vomica* L. | Nuxvomica Cuchala | Loganiaceae | Tree | Planted | - | - | Sonipat |
| 445. | *Suaeda fruticosa* (L.) Forsk | Lunaki | Amaranthaceae | Shrub | Native | - | Rewari, Mewat, | Hisar, Jind, Jhajjhar |
| 446. | *Swietenia mahagoni* (L.) Jacq. | Mahogani | Meliaceae | Tree | Planted | Morni-Pinjore | Gurgaon | Ambala, Kaithal |
| 447. | *Syzygium cuminii* Skeels | Jamun | Myrtaceae | Tree | Native | Common | Common | Common |
| 448. | *Syzygium jambos* (L.) Alston | Jangali Jamun, Gulab Jamun | Myrtaceae | Tree | Planted | Common | Common | Common |
| 449. | *Tabernaemontana divaricata* ( L.) R.Br. ex Roem. & Schult. | Chadani | Apocynaceae | Shrub | Planted | Common | Common | Common |
| 450. | *Tadehagi triquetrum* (L.) H. Ohashi, | Winged-Stalk Desmodiu m, | Fabaceae | Shrub | Native | KNP, Morni-Pinjore | - | - |
| 451. | *Tamarindus indica* L. | Imali | Fabaceae | Tree | Planted | Common | Common | Common |
| 452. | *Tamarix ericoides* Rottl. | Javuro | Tamaricaceae | Tree | Native | - | Gurugram, Mewat | - |
| 453. | *Tamarix indica* Willd. (*Tamarix troupii* Hole) | Jhau | Tamaricaceae | Tree | Native | - | Gurugram, Bhiwani | - |
| 454. | *Tamarix aphylla* (L.) H.Karst. | Llajhar | Tamaricaceae | Tree | Native | - | Bhiwani, Faridabad, Gurgram, M. Garh, Mewat, Rewari, | Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Palwal, Panipat, Rohtak, Sirsa, Sonepat |
| 455. | *Tamarix dioica* Roxb. ex Roth | Jhau | Tamaricaceae | Tree | Native | Morni-Pinjore | Bhiwani, Faridabad, M. Garh, Mewat, , Rewari | - |
| 456. | *Tamarix ramosissima* Ledeb | Tamarix | Tamaricaceae | Tree | Native | - | Rewari | Palwal |

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| 457. | *Tamilnadia uliginosa* (Retz.) Tirveng. & Sastre [ *Randia uliginosa* (Retz.) Poir.] | Pindalu | Rubiaceae | Tree | Native | Morni-Pinjore | - | - |
| 458. | *Tecomastans* (L.) Juss. ex Kunth | Piliya | Bignoniaceae | Tree | Planted | Common | Common | Common |
| 459. | *Tecomella undulata* (Roxb.) Seeman | Lohera, Roheda | Bignoniaceae | Tree | Native | - | Bhiwani, Faridabad, Gurgaon,, Rewari, M. Garh, Mewat, | Ambala, Fatehabad, Hisar, Jhajjar, Jind, Karnal, Panipat, Rohtak, Sirsa |
| 460. | *Tectona grandis* L. | Sagwan, Sagun | Lamiaceae | Tree | Planted | Common | Common | Common |
| 461. | *Tephrosia candida* (Roxb.) DC. | Safed Hori Matar | Fabaceae | Shrub | Native | - | - | Ambala, Kurukshetra |
| 462. | *Tephrosia falciformis* Ramaswami | Jhojharu | Fabaceae | Shrub | Native | - | M. Garh, Rewari | - |
| 463. | *Tephrosia purpurea* (L.) Persoon | Biyani, Sarphanko, Bisoni | Fabaceae | Shrub | Native | - | Common | Common |
| 464. | *Tephrosia uniflora* Pers. Subsp. *petrosa*(Blatt. & Hallb.) Gillett & Ali | Sarphonkha | Fabaceae | Shrub | Native | - | Rewari, Mewat | - |
| 465. | *Terminalia anogeissiana* Gere & Boatwr. [syn. *Anogeissus latifolia* (Roxb. ex DC) Wall ex Gill.] | Dhaoo, Dhau | Combretaceae | Tree | Native | Morni-Pinjore, KNP | - | - |
| 466. | *Terminalia arjunac* (Roxb. Ex DC.) Wight & Arn. | Arjun, Arjan | Combretaceae | Tree | Native (mostly planted) | Common | Common (mostly planted) | Common (mostly planted) |
| 467. | *Terminalia bellirica* (Gaertn.) Roxb. | Baheda | Combretaceae | Tree | Native | Common (Native) | Common (mostly planted) | Common (mostly planted) |
| 468. | *Terminalia chebula* Retz. | Harad | Combretaceae | Tree | Native (mostly planted) | Common (Native) | Common (mostly planted) | Common (mostly planted) |
| 469. | *Terminalia coronata* (Stapf) | Dhauro, | Combretaceae | Tree | Native | - | | - |

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| | Gere & Boatwr. (syn. *Anogeissus sericea* var. *nummularia* King ex Duthie) | Indoko, Dhoh | | | | | Mewat | |
| 470. | *Terminalia coronata* var. *parvifolia* (C.B.Clarke) Chakrab. & Anand Kumar (syn. *Anogeissus sericea* Brandis) | Daukada, Dhawral | Combretaceae | Tree | Native | - | Mewat | - |
| 471. | *Terminalia elliptica* Willd (syn. *Terminalia alata* B.Heyne ex Roth) | Asana, Sain | Combretaceae | Tree | Native | KNP, Morni hills | - | Ambala |
| 472. | *Terminalia pendula* (Edgew.) Gere & Boatwr. ( *Anogeissus pendula* Edgew.) | Kardhai, Dhau, Dhauro, Chau, Endruk | Combretaceae | Tree | Native | - | Faridabad, Gurgaon, M. Garh, Mewat, Rewari | Palwal, Fatehabad, |
| 473. | *Terminalia catappa* L. | Desibadam | Combretaceae | Tree | Planted | - | Gurugram | - |
| 474. | *Thespesia lampas* (Cav.) Dalzell & Gibson | Jangali bhindi, Bankapasi | Malvaceae | Shrub | Native | KNP, Morni hills | | Ambala |
| 475. | *Thunbergia fragrans* Roxb. | Chimeen | Acanthaceae | Climber | Native | KNP, Morni hills | | Yamuna Nagar |
| 476. | *Tinospora cordifolia* (Willd.) Miers | Giloy, Gulbel, Urajio, Arjuna | Menispermaceae | Climber | Native | Common | Common | Common |
| 477. | *Toona ciliata* M.Roem. (syn. *Cedrela toona* Roxb. ex Rottler & Willd.) | Toon | Meliaceae | Tree | Planted | Common | Common | Common |
| 478. | *Trema orientalis* (L.) Blume | Jeewanti | Cannabaceae | Tree | Native | KNP, Morni-Pinjore | - | - |
| 479. | *Trema politoria* (Planch.) Blume | Khaishagi | Cannabaceae | Tree | Native | KNP, Morni-Pinjore | - | Yamuna Nagar |
| 480. | *Triadica sebifera* (L.) Small | | Euphorbiaceae | Tree | Planted | KNP, | - | Ambala |

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| | | Talcharbi | | | (Naturalized) | Morni-Pinjore | | |
| 481. | *Trichosanthes cucumerina* L. | Jangali ChinchidaChichoda | Cucurbitaceae | Climber | Native | | Gurgram | Karnal, Kurukshetra, Yamuna Nagar |
| 482. | *Triumfetta rhomboidea* Jacq. | Pali, Leehing, Chiryari | Malvaceae | Shrub | Native | Common | Common | Common |
| 483. | *Typha elephantina* Roxb. | Pater, Patera | Typhaceae | Shrub | Native | - | Gurgram | Yamuna Nagar |
| 484. | *Uraria picta* (Jacq.) DC. | Pitwan, Dabar | Fabaceae | Shrub | Native | Morni-Pinjore | - | - |
| 485. | *Urena lobata* L. | Chitlang, Lapetua, Bachita, Unga | Malvaceae | Shrub | Native | KNP, Morni-Pinjore | Bhiwani, Gurgaon, M. Garh, Mewat, Palwal, Rewari, | Ambala, Yamuna Nagar, |
| 486. | *Vachellia eburnea* (L.f.) P.J.H.Hurter & Mabb. [syn. *Acacia eburnea* (L. f.) Willd.] | Pahadi Kikar | Fabaceae | Small Tree | Native | KNP | - | - |
| 487. | *Vachellia farnesiana* (L.) Wi [syn. *Acacia farnesiana* (L.) Willd.] | Vilayati Kikar | Fabaceae | Shrub | Planted | Common | Common | Common |
| 488. | *Vachellia jacquemontii* (Benth.) Ali [syn. *Acacia jacquemontii* Benth.] | Bu-banvali, Ratio-banwal | Fabaceae | Shrub | Native | - | Gurugram, Mewat, Rewari | Hisar |
| 489. | *Vachellia leucophloea* (Roxb.) Maslin, Seigler &Ebinger [syn. *Acacia leucophloea* (Roxb.) Willd.] | Reru, Urajio, Arjuna | Fabaceae | Tree | Native | Morni hills | Gurgaon, Bhiwani, Faridabad, M. Garh, | Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Mewat, Palwal, Panipat, Rewari, Rohtak, Sirsa, Sonipat, Kaithal |
| 490. | *Vachellia nilotica* subsp. *indica* (Benth.) Kyal. & | Banbal, Babool | Fabaceae | Tree | Native | Common | Common | Common |

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| | Boatwr [syn. *Acacia nilotica* (L.) Del.ssp. *indica* (Benth.) Brenan] | | | | | | | |
| 491. | *Vachellia tortilis* (Forssk.) Galasso & Banfi [syn. *Acacia tortilis* (Forssk.) Hayne] | Aiala | Fabaceae | Shrub | Native | - | Bhiwani, Faridabad, Gurgram, M. Garh, Mewat, Rewari | Fatehabad, Hisar, Jind, Karnal, Kurukshetra, Palwal, Panipat, Sirsa |
| 492. | *Vallaris solanacea* (Roth.) Kuntze | Dudhi ki bel | Apocynaceae | Climber | Native | KNP, Morni-Pinjore, | Gurugram, Bhiwani, Faridabad, Rewari, M. Garh, Mewat, | Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Sonipat, Yamuna Nagar |
| 493. | *Ventilago denticulata* Willd. | Raidhani | Rhamnaceae | Climber | Native | KNP | - | - |
| 494. | *Vincetoxicum spirale* (Forssk.) D.Z.Li [*Blyttia spiralis* (Forssk.) D.V.Field & J.R.I.Wood] | Akaribel Dahiyal | Apocynaceae | Climber | Native | - | Gurugram | Bhiwani, Jind, Karnal, Panipat |
| 495. | *Viscum loranthi* Elmer | Jungali band | Santalaceae | Shrub | Native | Morni hills | - | - |
| 496. | *Vitex negundo* L. | Nirgundi | Lamiaceae | Shrub | Native | KNP, Morni-Pinjore, | Common | Kurukshetra, Yamuna Nagar |
| 497. | *Vitex peduncularis* Wall. ex Schauer | Urikshibiman | Lamiaceae | Tree | Planted | Morni-Pinjor | - | - |
| 498. | *Vitis vinifera* L. | Angur | Vitaceae | Climber | Planted | Common | Common | Common |
| 499. | *Volkameria inermis* L.[Syn.*Clerodendrum inerme* (L.) Gaertner] | Sankuppi | Lamiaceae | Shrub | Planted | Common | Common | Common |
| 500. | *Wendlandia heynei* (Roemer & Schultes) Santapau & Merchant | China | Rubiaceae | Tree | Native | Morni-Pinjore, KNP | - | - |
| 501. | *Withania somnifera* (L.) Dunal | Ashwagandha | Solanaceae | Shrub | Planted | Common | Common | Common |

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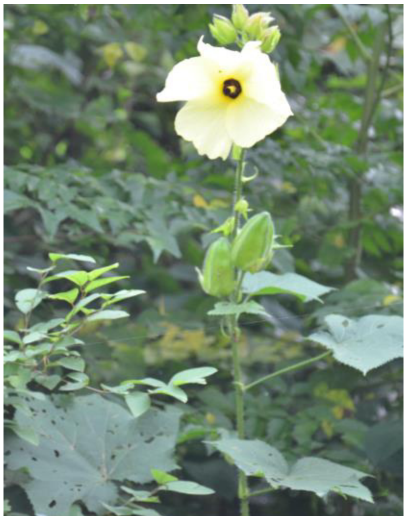
| 502. | *Woodfordia fruticosa* (L.) Kurz | Dhavi, Dhai | Lythraceae | Tree | Native | Morni-Pinjore, KNP | - | Ambala, Yamuna Nagar |
| 503. | *Wrightia arborea* (Dennst.) Mabberley | Dudhi, Indrjau, Bhakar-Aak, Kerno | Apocynaceae | Tree | Native | Morni-Pinjore, KNP | - | Ambala, Yamuna Nagar |
| 504. | *Wrightia tinctoria* R.Br. | Bhakar-Aak, Kerno | Apocynaceae | Tree | Native | - | Gurugram, Rewari, Bhiwani | - |
| 505. | *Xanthium strumarium* L. | hota Gokhru | Asteraceae | Shrub | Native | Common | Common | Common |
| 506. | *Xylosma longifolia* Clos | Katari | Salicaceae | Tree | Native | KNP, Morni hills | - | - |
| 507. | *Zanthoxylum armatum* DC. | *Tejbal, Timbur* | Rutaceae | Shrub | Native | Morni hills | - | - |
| 508. | *Ziziphus glaberrima* (Sedgwick) Santapau | Kath ber, Kaath ber | Rhamnaceae | Tree | Native | KNP. Morni hills | - | - |
| 509. | *Ziziphus jujuba* Mill. | Ber | Rhamnaceae | Tree | Native | Common | Common | Common |
| 510. | *Ziziphus nummularia* (Burm.f.) Wight & Arn. | Jharkhi, Jharberi, Jhadiber | Rhamnaceae | Shrub | Native | Morni hills | Common | Common |
| 511. | *Ziziphus oenoplia* L. | Makoh, Bamolan | Rhamnaceae | Climbing Shrub | Native | Morni hills, KNP | Gurugram, Rewari, Bhiwani | Ambala |
| 512. | *Ziziphus xylopyrus* (Retz.) Willd. | Kathber | Rhamnaceae | Tree | Native | KNP | - | Ambala |

**Shiwalik Ranges:** Yamuna Nagar (Kalesar National Park, Morni Hills, Pinjore); **Aravalli Range:** Mewat, Mahendergarh, Rewari, Gurugaon, Faridabad, Bhiwani; **Plains:** (Ambala, Fatehabad, Hisar, Jhajjar, Jind, Kaithal (including Sarswati Conservation Reserve), Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Sonipat

**Plate 1**



*Abelmoschus moschatus*

*Abrus precatorius*

*Abutilon indicum*

*Achyranthes aspera*

*Adansonia digitata*

*Adenanthera microsperma*

*Adina cordifolia*

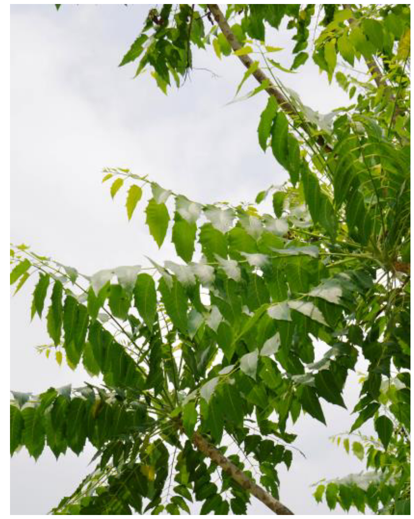
*Aegle marmelos*

*Aerva javanica*

**Plate 2**

***Agathis robusta***

***Agave vivipara***



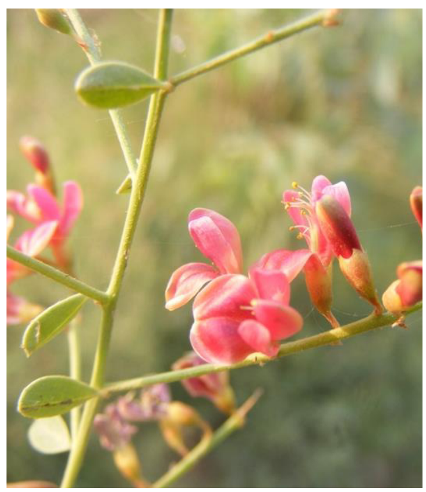
***Ailanthus excelsa***

***Albizia chinensis***

***Albizia lebbeck***

***Albizia odoratissima***

***Albizia procera***



***Alhagi maurorum***

***Alstonia scholaris***

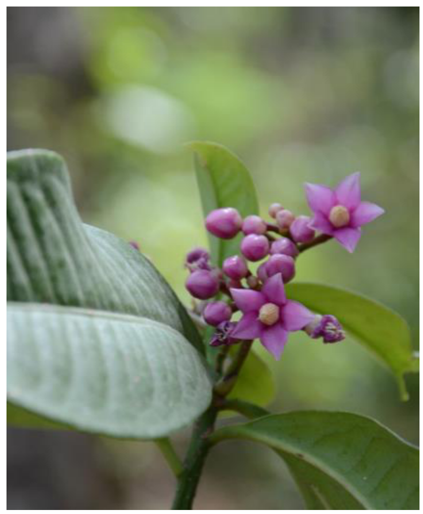
**Plate 3**

*Ampelocissus latifolia*

*Annona squamosa*

*Antidesma acidum*

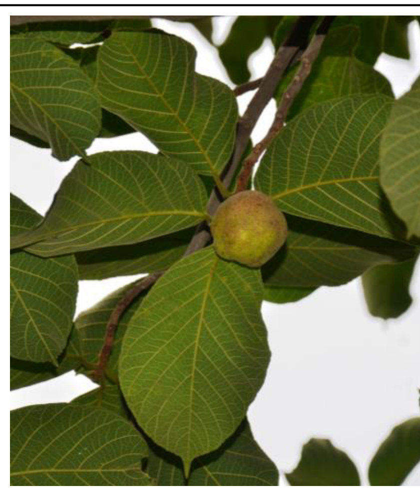
*Antigonon leptopus*



*Ardisia solanacea*

*Artabotrys hexapetalus*

*Artocarpus heterophyllus*



*Artocarpus lacucha*

*Asclepias curassavica*

**Plate 4**

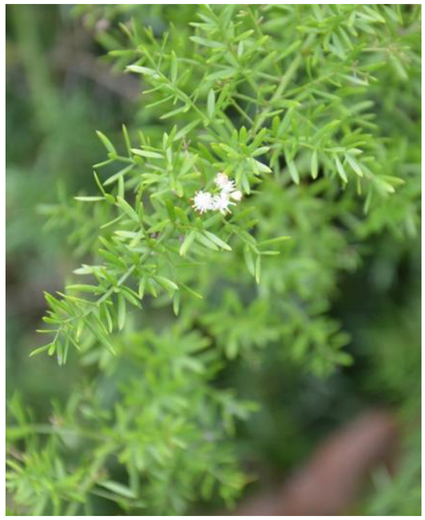
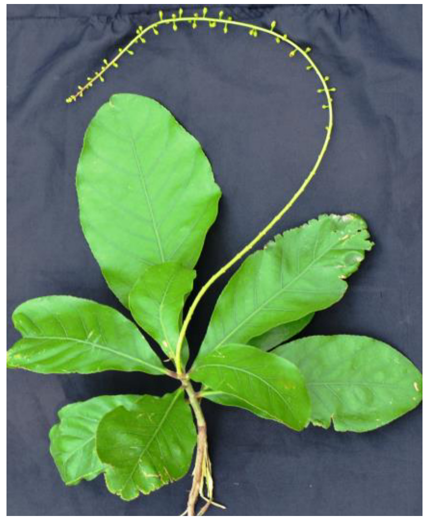
| | | |
|---|---|---|
|  |  |  |
| ***Asparagus adscendens*** | ***Asparagus racemosus*** | ***Aspidopterys wallichii*** |
|  |  |  |
| ***Averrhoa carambola*** | ***Azadirachta indica*** | ***Balanites aegyptiaca*** |
|  |  |  |
| ***Baliospermum montanum*** | ***Bambusa bambos*** | ***Barleria cristata*** |

**Plate 5**

***Barleria prionitis***



***Barringtonia acutangula***

***Bauhinia purpurea***

***Bauhinia racemosa***

***Bauhinia variegata***

***Beaucarne recurvata***

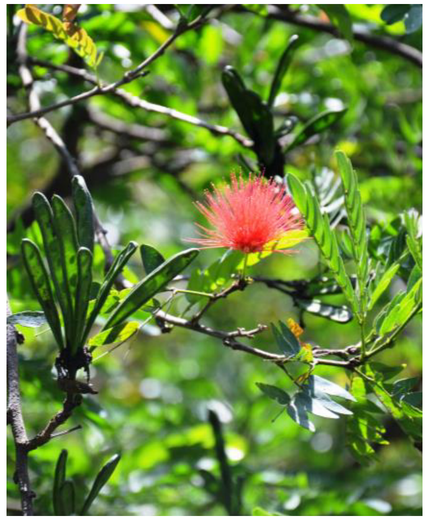
***Berberis asiatica***

***Berberis lycium***

***Bergera koenigii***

**Plate 6**

*Biancaea decapetala*



*Calliandra haematocephala*

*Bischofia javanica*

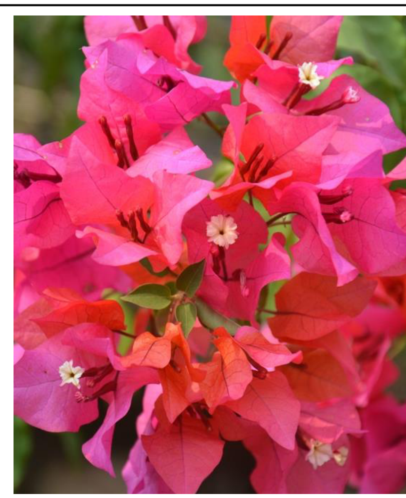
*Bixa orellana*

*Boehmeria macrophylla*

*Bombax ceiba*

*Borassus flabellifer*

*Boswellia serrata*



*Bougainvillea spectabilis*

**Plate 7**

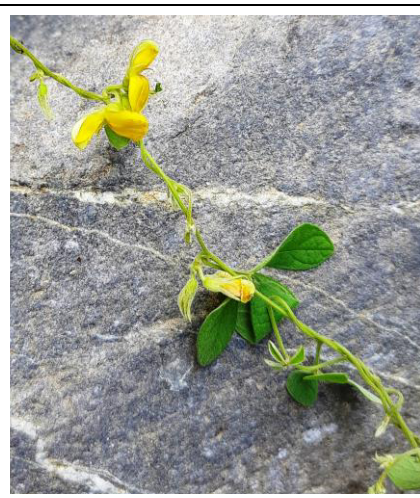
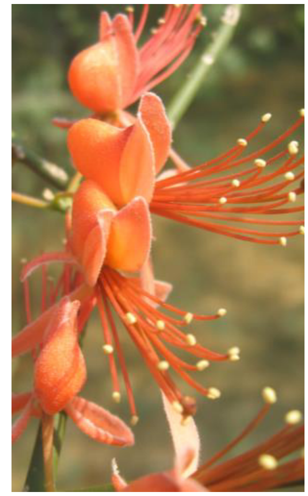
| | | |
|---|---|---|
|  |  |  |
| ***Breynia vitis-idaea*** | ***Bridelia retusa*** | ***Broussonetia papyrifera*** |
|  |  |  |
| ***Buchanania lanzan*** | ***Buddleja asiatica*** | ***Butea monosperma*** |
|  |  |  |
| ***Caesalpinia pulcherrima*** | ***Cajanus scarabaeoides*** | ***Callicarpa macrophylla*** |

**Plate 8**

*Calotropis gigantea*

*Calotropis procera*

*Canavalia gladiata*



*Capparis decidua*

*Capparis sepiaria*

*Capparis zeylanica*

*Cardiospermum halicacabum*

*Careya arborea*

*Carissa spinarum*

*Carissa carandas*

**Plate 9**

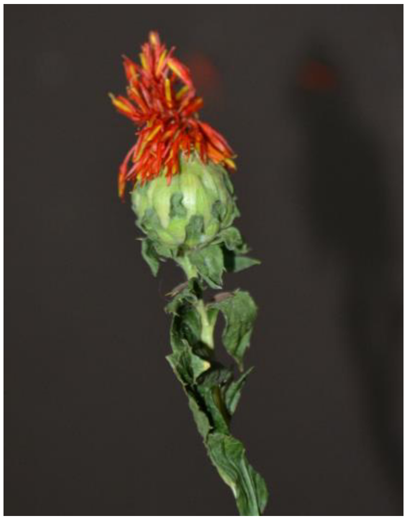
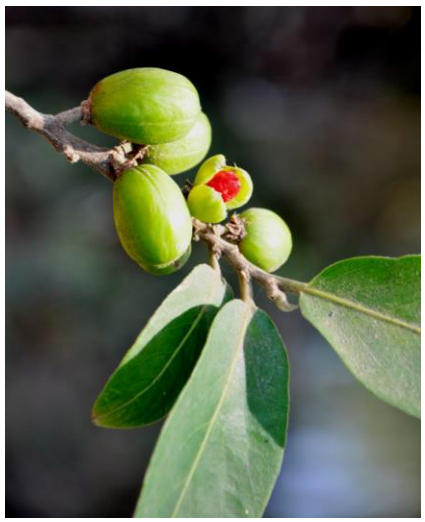
| | | |
|---|---|---|
|  |  |  |
| *Carthamus tinctorius* | *Caryota urens* | *Cascabela thevetia* |
|  |  |  |
| *Casearia graveolens* | *Casearia tomentosa* | *Cassia fistula* |
|  |  |  |
| *Cassia javanica subsp. nodosa* | *Cassine glaucum* | *Casuarina equisetifolia* |

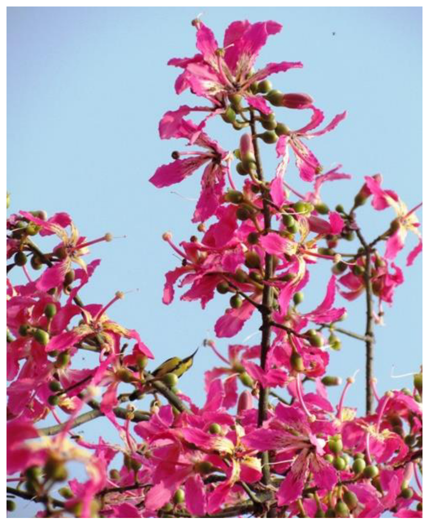
**Plate 10**

*Catamixis baccharoides*

*Catunaregam spinosa*

*Cayratia trifolia*

*Cebatha pendula*



*Ceiba speciosa*

*Celastrus paniculata*

*Celosia argentea*

*Celtis tetrandra*

*Cestrum parqui*

**Plate 11**

| | | |
|---|---|---|
|  |  |  |
| ***Cestrum nocturnum*** | ***Chukrasia tabularis*** | ***Cissampelos pareira*** |
|  |  |  |
| . ***Cissus quadrangularis*** | ***Cissus repanda*** | ***Citrus aurantiifolia*** |
|  |  |  |
| ***Citrus aurantium*** | ***Citrus limon*** | ***Citrus maxima*** |

**Plate 12**

*Citrus medica*

*Clematis buchananiana*

*Clematis gouriana*

*Clematis roylei*

*Cleome viscosa*

*Clerodendrum chinense*

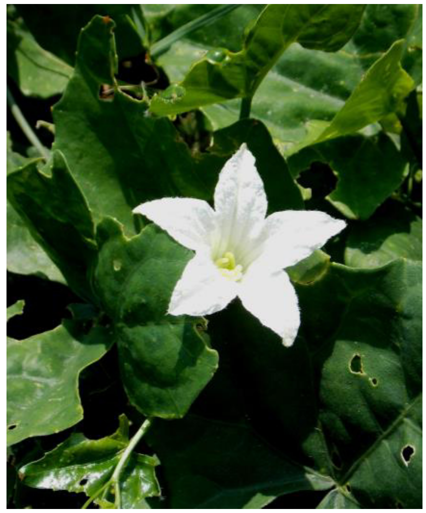
*Clerodendrum indicum*

*Clerodendrum infortunatum*

*Clerodendrum phlomidis*

**Plate 13**

*Clitoria ternatea*



*Coccinia grandis*

*Cocculus hirsutus*

*Codariocalyx motorius*

*Colebrookea oppositifolia*

*Combretum indicum*

*Commiphora wightii*

*Conocarpus lancifolius*

*Corchorus aestuans*

**Plate 14**

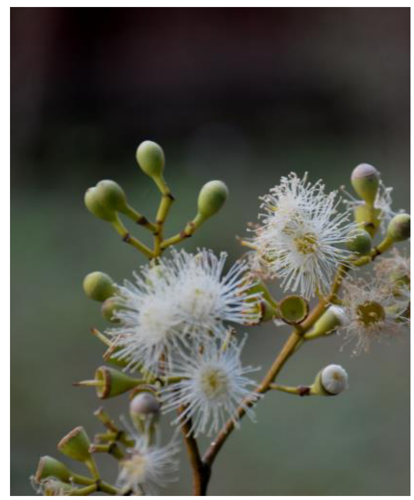
| | | |
|---|---|---|
|  |  |  |
| ***Corchorus capsularis*** | ***Cordia dichotoma*** | ***Cordia sinensis*** |
|  |  |  |
| ***Cordia vestita*** | ***Cordia macleodii*** | ***Corymbia citriodora*** |
|  |  |  |
| ***Crateva magna*** | ***Crateva adansonii*** | ***Crotalaria burhia*** |

**Plate 15**

***Crotalaria medicaginea***

***Crotalaria sericea***

***Croton bonplandianus***

***Cryptolepis buchananii***

***Cucumis maderaspatanus***

***Dalbergia sissoo***

***Dalbergia lanceolaria***

***Datura stramonium***

***Debregeasia saeneb***

**Plate 16**

*Delonix regia*

*Dendrocalamus hamiltonii*

*Dendrocalamus strictus*

*Dendrophthoe falcata*

*Dichrostachys cinerea*

*Dillenia indica*

*Dioscorea belophylla*

*Dioscorea bulbifera*

*Diospyros malabarica*

**Plate 17**

***Diospyros melanoxylon***

***Diospyros montana***

***Diplocyclos palmatus***

***Distimake aegyptius***

***Dodonaea viscosa***

***Dombeya burgessiae***

***Duhaldea cappa***

***Duranta erecta***

***Ehretia laevis***

**Plate 18**

*Ehretia acuminata*

*Engelhardtia spicata*

*Ephedra ciliata*

*Eranthemum pulchellum*

. *Eriobotrya japonica*

*Erythrina suberosa*

*Erythrina variegata*

*Eucalyptus tereticornis*

*Eucalyptus camaldulensis*

**Plate 19**

***Eucalyptus paniculata***

***Euphorbia caducifolia***

***Euphorbia neriifolia***

***Euphorbia pulcherrima***

***Euphorbia royleana***

***Falconeria insignis***

***Fernandoa adenophylla***

***Ficus auriculata***

***Ficus benghalensis***

**Plate 20**

***Ficus benjamina***

***Ficus elastica***

***Ficus hispida***

***Ficus mollis***

***Ficus palmata* subsp. *virgata***

***Ficus racemosa***

***Ficus religiosa***

***Ficus semicordata***

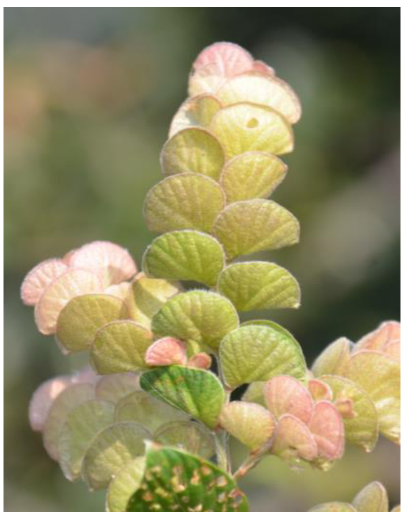
***Ficus virens***

**Plate 21**

*Ficus rumphii*

*Flacourtia indica*

*Flacourtia jangomas*



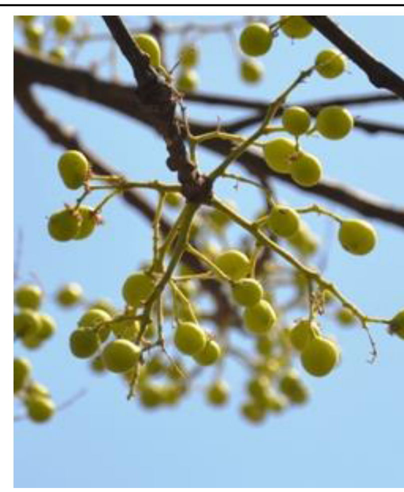
*Flemingia bracteata*

*Flemingia macrophylla*

*Flemingia strobilifera*

*Flueggea leucopyrus*

*Gardenia jasminoides*



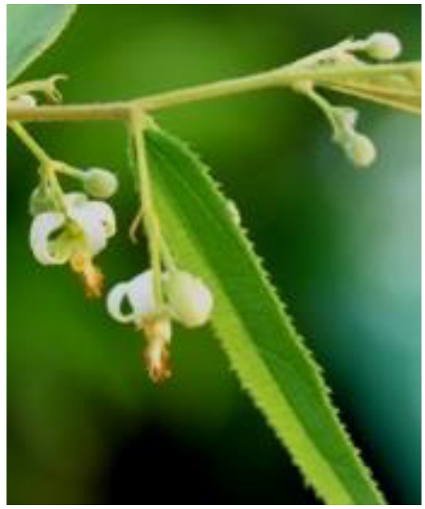
*Garuga pinnata*

**Plate 22**

| | | |
|---|---|---|
|  |  |  |
| ***Glochidion heyneanum*** | ***Gloriosa superba*** | ***Glycyrrhiza glabra*** |
|  |  |  |
| ***Gmelina arborea*** | ***Gossypium arboreum*** | ***Grevillea robusta*** |
|  |  |  |
| ***Grewia asiatica*** | ***Grewia optiva*** | ***Grewia tenax*** |

**Plate 23**

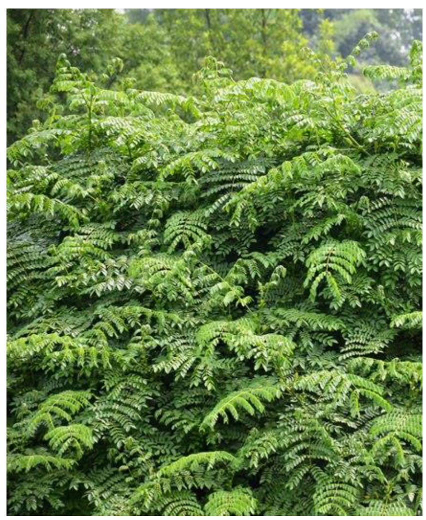
*Grewia flavescens*



*Grewia hirsuta*

*Grewia serrulata*

*Grewia tiliifolia*



*Guilandina bonduc*

*Gymnosporia emarginata*

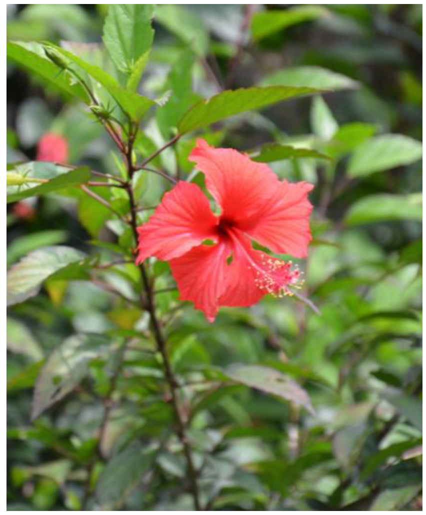
*Hamelia patens*

*Helicteres isora*

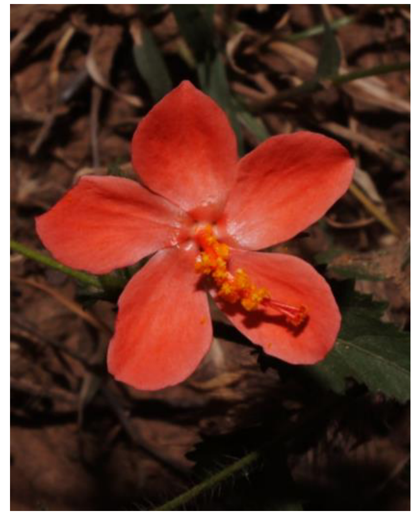
*Helinus lanceolatus*

**Plate 24**

***Hemidesmus indicus***

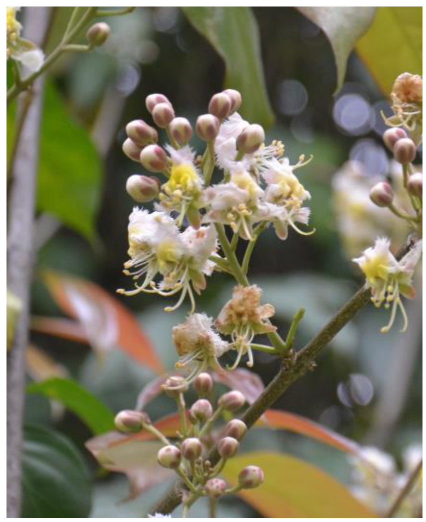


***Hibiscus rosa-sinensis***



***Hibiscus micranthus***

***Hibiscus syriacus***



***Hiptage benghalensis***

***Holarrhena pubescens***

***Holoptelea integrifolia***

***Hymenodictyon orixense***

***Ichnocarpus frutescens***

**Plate 25**

*Indigofera atropurpurea*

*Indigofera cassioides*

*Indigofera heterantha*

*Ipomea pes-tigridis*

*Ipomoea cairica*

*Ipomoea carnea subsp. fistulosa*

*Ipomoea hederifolia*

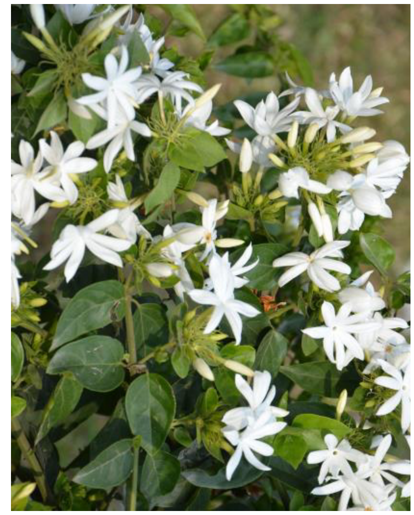
*Ipomoea nil*

*Ipomoea triloba*

**Plate 26**

*Ixora coccinea*

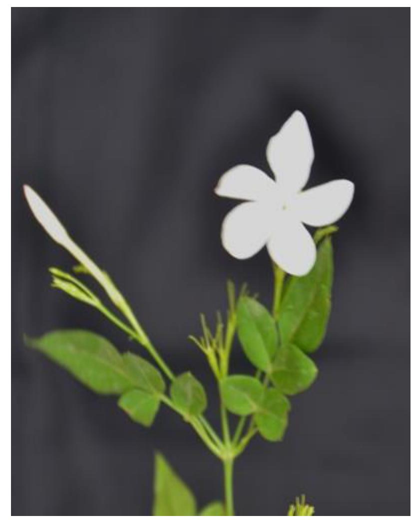
*Jacaranda mimosifolia*



*Jasminum arborescens*

*Jasminum multiflorum*

*Jasminum sambac*



*Jasminum grandiflorum*

*Jasminum humile*

*Jatropha curcas*

*Jatropha gossypifolia*

**Plate 27**

*Justicia adhatoda*

*Kigelia africana*

*Kydia calycina*

*Lagerstroemia indica*

*Lagerstroemia parviflora*

*Lagerstroemia speciosa*

*Lannea coromandelica*

*Lantana camara*

*Lawsonia inermis*

**Plate 28**

***Leea asiatica***

***Leptadenia pyrotechnica***

***Leptadenia reticulata***

***Leptopus cordifolius***

***Lespedeza juncea* var. *sericea***

***Leucaena leucocephala***

***Leucomeris spectabilis***

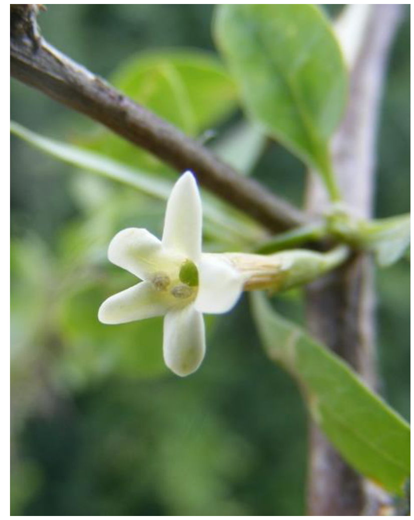
***Lippia alba***

***Litchi chinensis***

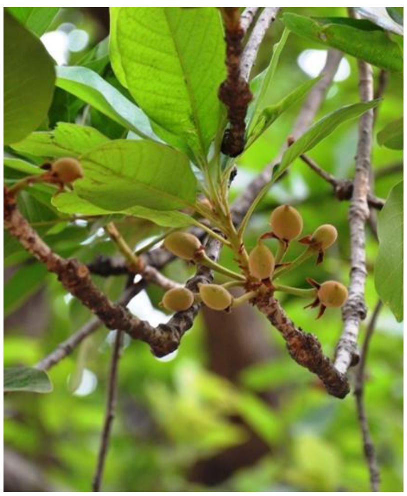
**Plate 29**

*Litsea glutinosa*

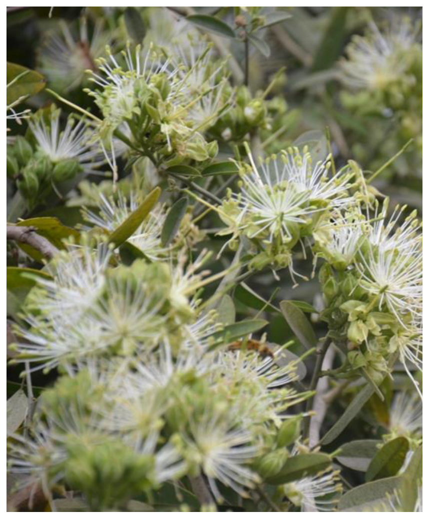
*Livistona chinensis*



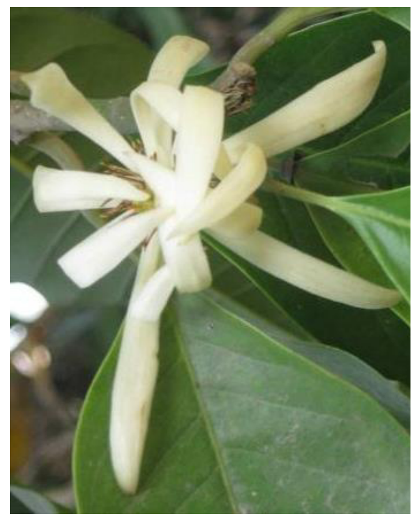
*Lycium barbarum*



*Madhuca longifolia* var. *latifolia*



*Maerua oblongifolia*



*Magnolia champaca*

*Mallotus nudiflorus*

*Mallotus philippensis*

*Malvastrum coromandelianum*

**Plate 30**

| | | |
|---|---|---|
|  |  |  |
| ***Mangifera indica*** | ***Manilkara zapota*** | ***Manilkara hexandra*** |
|  |  |  |
| ***Maoutia puya*** | ***Marsdenia roylei*** | ***Martynia annua*** |
|  |  |  |
| ***Melaleuca viminalis*** | ***Melia azedarach*** | ***Melochia corchorifolia*** |

**Plate 31**

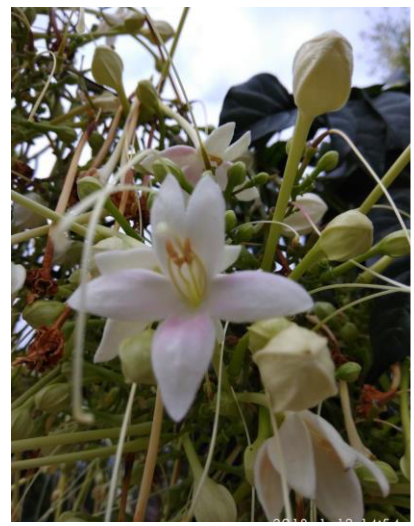
*Merremia hederacea*

*Mesua ferrea*

*Miliusa velutina*

*Millettia extensa*

*Millettia peguensis*



*Millingtonia hortensis*

*Mimosa rubicaulis*

*Mimosa pudica*

*Mimusops elengi*

**Plate 32**

*Mitragyna parvifolia*

*Momordica dioica*

*Morinda pubescens*

*Morinda citrifolia*

*Moringa oleifera*

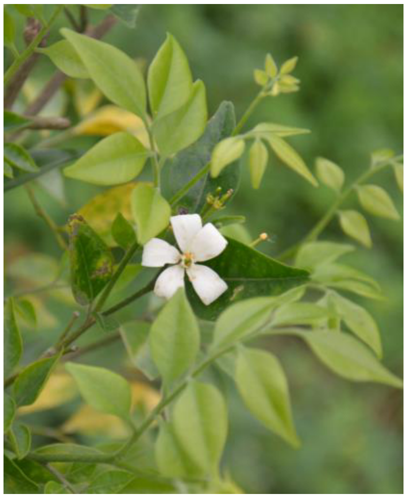
*Morus alba*

*Mucuna pruriens*

*Mucuna nigricans*

*Mukia maderaspatana*

**Plate 33**



*Murraya paniculata*

*Myrsine africana*

*Naringi crenulata*

*Neolamarckia cadamba*

*Nerium oleander*

*Nicandra physalodes*

*Nyctanthes arbortristis*

*Olax nana*

*Olea glandulifera*

**Plate 34**

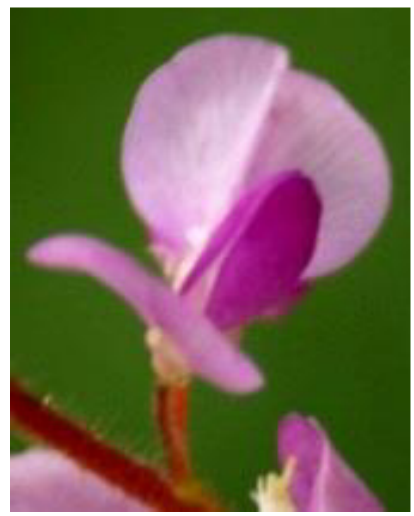
***Olea paniculata***

***Opuntia dillenii***

***Opuntia elatior***

***Oroxylum indicum***

***Osyris lanceolata***



***Ototropis multiflora***

***Oxystelma esculentum***

***Pachygone laurifolia***

***Parkinsonia aculeata***

**Plate 35**

*Parthenocissus semicordata*

*Passiflora foetida*

*Passiflora suberosa*

*Pavetta indica*

*Pergularia daemia*

*Persicaria chinensis*

*Phanera retusa*

*Phanera vahlii*

*Phlogacanthus thyrsiformis*

**Plate 36**

***Phoenix loureiroi***

***Phoenix acaulis***

***Phoenix sylvestris***

***Phyllanthus emblica***

***Phyllanthus reticulatus***

***Phyllodium pulchellum***

***Piliostigma malabaricum***

***Pinus roxburghii***

***Pistacia chinensis*** **subsp.** ***integerrima***

**Plate 37**

***Pithecellobium dulce***

***Pleurolobus gangeticus***

***Plumbago arabica***

***Plumbago zeylanica***

***Plumeria rubra***

***Pogostemon benghalense***

***Polhillides velutina***

***Polyalthia longifolia***

***Populus deltoides***

**Plate 38**

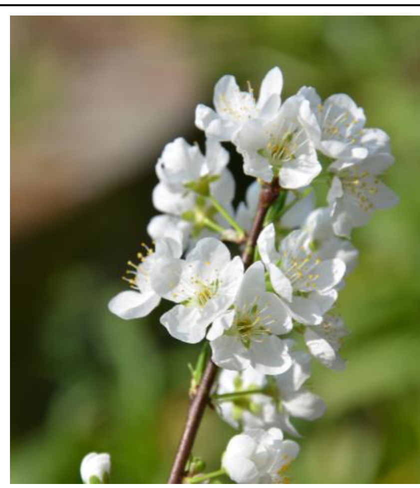
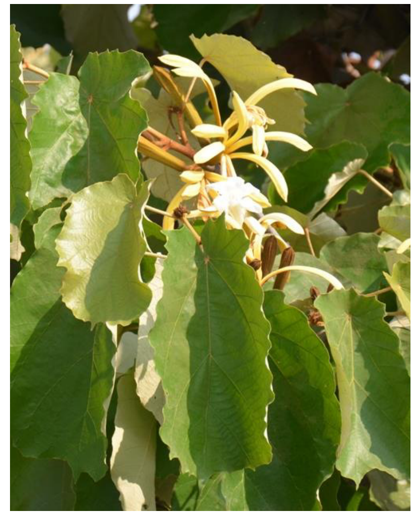
| | | |
|---|---|---|
|  |  |  |
| ***Poranopsis paniculata*** | ***Pouzolzia rugulosa*** | ***Premna barbata*** |
|  |  |  |
| ***Premna latifolia*** | ***Prosopis juliflora*** | ***Prosopis cineraria*** |
|  |  |  |
| ***Prunus persica*** | ***Prunus domestica* subsp. *insititia*** | ***Pseudocaryopteris bicolor*** |

**Plate 39**

***Psidium guajava***

***Psilanthus bengalensis***



***Pterospermum acerifolium***

***Pterygota alata***

***Pueraria tuberosa***

***Punica granatum***

***Putranjiva roxburghii***

***Pyracantha crenulata***

***Pyrostegia venusta***

**Plate 40**

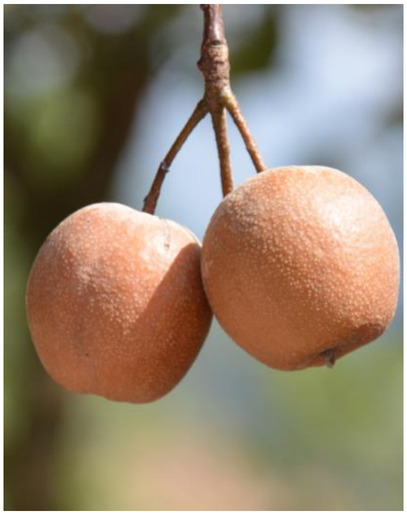
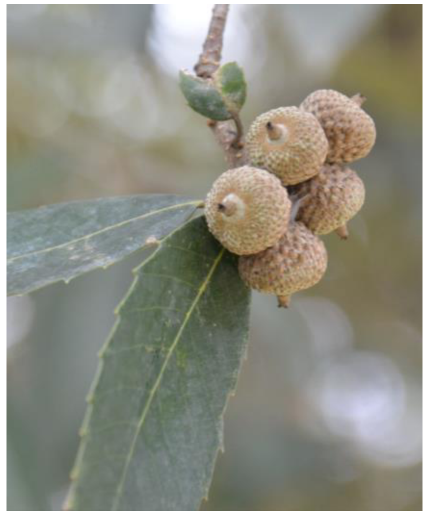
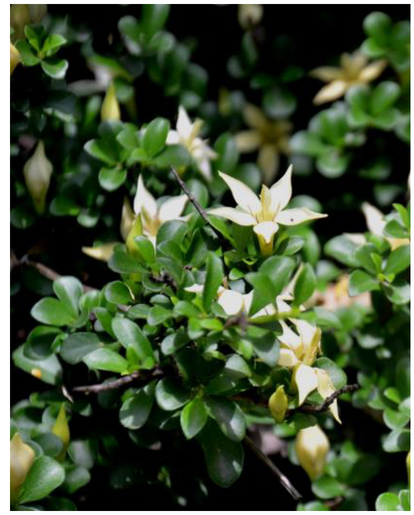
| | | |
|---|---|---|
|  |  |  |
| ***Pyrus pashia*** | ***Quercus leucotrichophora*** | ***Randia tetrasprema*** |
|  |  |  |
| ***Rauvolfia serpentina*** | ***Rhamnus triqueter*** | ***Rhynchosia minima*** |
|  |  |  |
| ***Rhynchosia rothii*** | ***Ricinus communis*** | ***Rivea ornata*** |

**Plate 41**

| | | |
|---|---|---|
|  |  |  |
| ***Rosa moschata*** | ***Roylea cinerea*** | ***Roystonea regia*** |
|  |  |  |
| ***Rubia manjith*** | ***Rubus ellipticus*** | ***Rubus niveus*** |
|  |  |  |
| ***Salix acmophylla*** | ***Salvadora oleoides*** | ***Sapindus mukorossi*** |

**Plate 42**

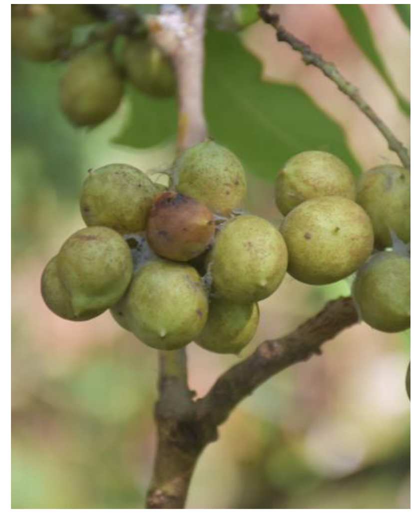
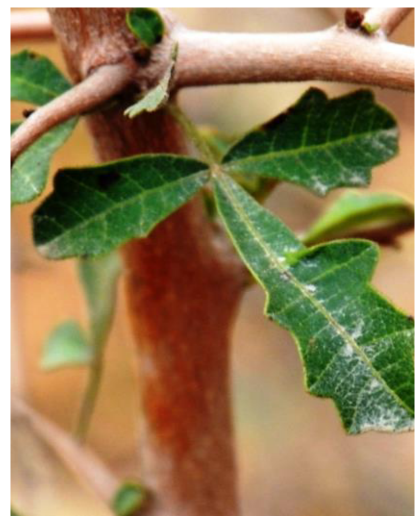
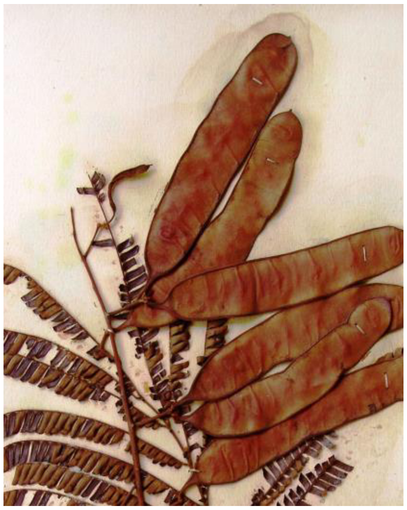
| | | |
|---|---|---|
|  |  |  |
| ***Sapindus emarginatus*** | ***Saraca asoca*** | ***Schleichera oleosa*** |
|  |  |  |
| ***Scurrula cordifolia*** | ***Scurrula pulverulenta*** | ***Searsia mysorensis*** |
|  |  |  |
| ***Searsia parviflora*** | ***Semecarpus anacardium*** | ***Senegalia catechu*** |

**Plate 43**



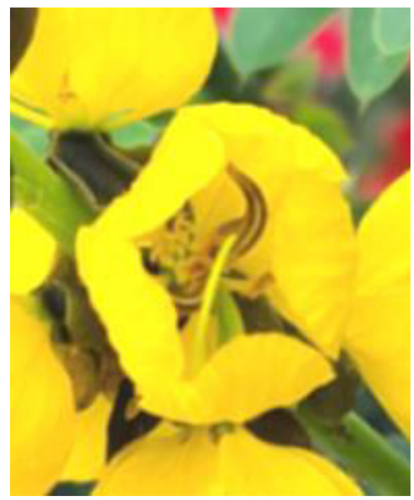
***Senegalia gageana***

***Senegalia modesta***

***Senegalia pennata***

***Senegalia senegal***

***Senegalia torta***



***Senna didymobotrya***

***Senna occidentalis***

***Senna septemtrionalis***

***Senna siamea***

**Plate 44**

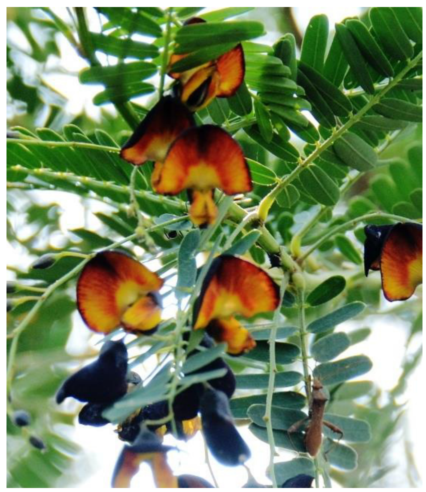
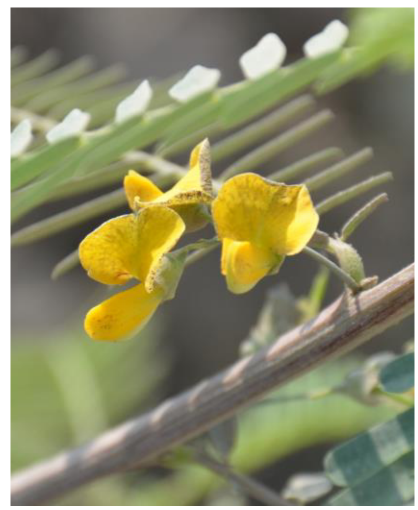
| | | |
|---|---|---|
|  |  |  |
| ***Senna sulfurea*** | ***Senna tora*** | ***Senna auriculata*** |
|  |  |  |
| ***Sericostoma pauciflorum*** | ***Sesbania bispinosa*** | ***Sesbania sesban*** |
|  |  |  |
| ***Shorea robusta*** | ***Shuteria involucrata*** | ***Sida acuta*** |

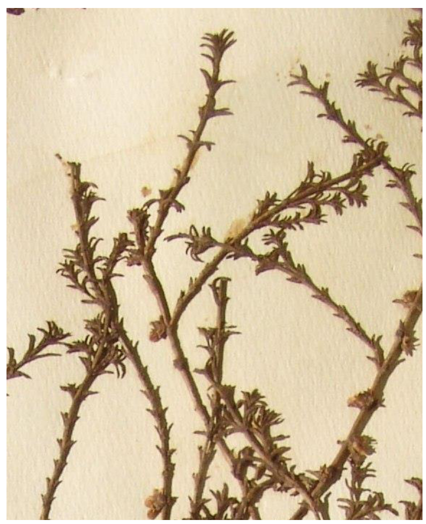
**Plate 45**

***Sida cordifolia***

***Sida cordata***

***Sida rhombifolia***

***Smilax zeylanica***



***Soda stocksii***

***Solanum erianthum***

***Solanum incanum***

***Solanum sisymbriifolium***

***Solanum torvum***

**Plate 46**

*Solanum viarum*

*Solanum virginianum*

*Solena amplexicaulis*

*Solena heterophylla*

*Spermadictyon suaveolens*

*Spondias pinnata*

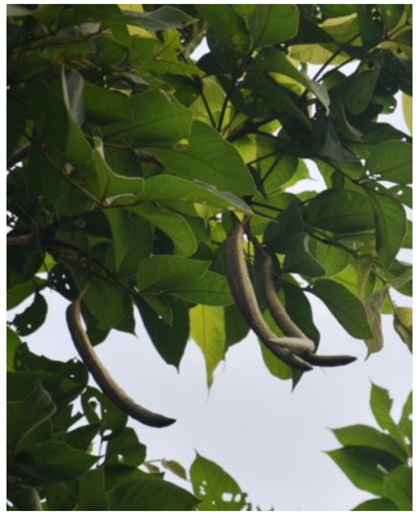
*Stephania glabra*

*Stephanotis volubilis*

*Sterculia urens*

**Plate 47**

***Sterculia villosa***



***Stereospermum chelonoides***

***Streblus asper***

***Strobilanthes atropurpurea***

***Strobilanthes wallichii***

***Strychnos nux-vomica***

***Suaeda fruticosa***

***Swietenia mahagoni***

***Syzygium cuminii***

**Plate 48**

| | | |
|---|---|---|
|  |  |  |
| ***Syzygium jambos*** | ***Tabernaemontana divaricata*** | ***Tadehagi triquetrum*** |
|  |  |  |
| ***Tamarindus indica*** | ***Tamarix indica*** | ***Tamarix aphylla*** |
|  |  |  |
| ***Tamarix dioica*** | ***Tamarix ramosissima*** | ***Tamilnadia uliginosa*** |

**Plate 49**

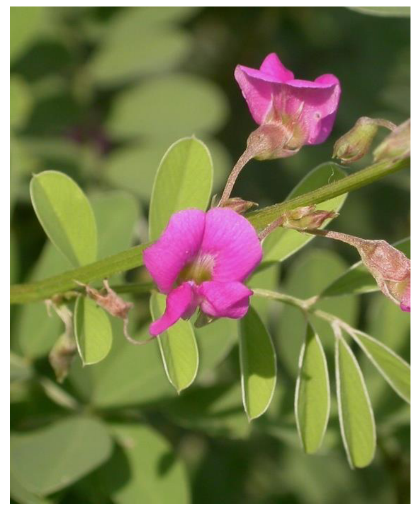
*Tecoma stans*

*Tecomella undulata*

*Tectona grandis*

*Tephrosia candida*

*Tephrosia falciformis*



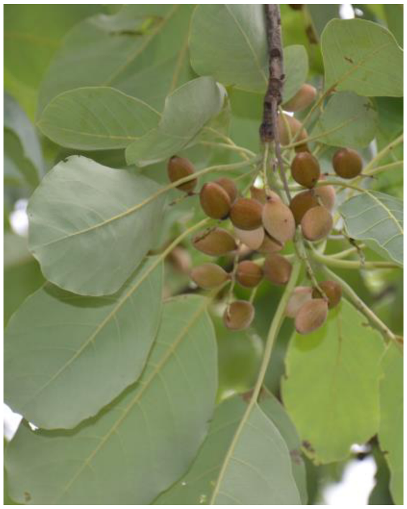
*Tephrosia purpurea*

*Tephrosia uniflora*

*Terminalia anogeissiana*

*Terminalia arjuna*

**Plate 50**



***Terminalia bellirica***

***Terminalia chebula***

***Terminalia coronata***

***Terminalia coronata*** var. ***parvifolia***

***Terminalia elliptica***

***Terminalia pendula***

***Terminalia catappa***

***Thespesia lampas***

***Thunbergia fragrans***

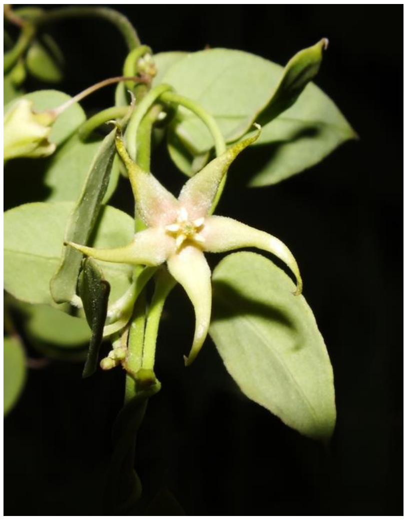
**Plate 51**

| | | |
|---|---|---|
|  |  |  |
| *Tinospora cordifolia* | *Toona ciliata* | *Trema orientalis* |
|  |  |  |
| *Trema politoria* | *Triadica sebifera* | *Trichosanthes cucumerina* |
|  |  |  |
| *Triumfetta rhomboidea* | *Typha elephantina* | *Uraria picta* |

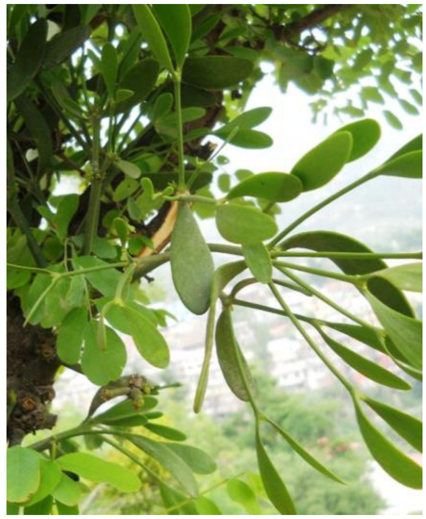
**Plate 52**

| | | |
|---|---|---|
|  |  |  |
| ***Urena lobata*** | ***Vachellia eburnea*** | ***Vachellia farnesiana*** |
|  |  |  |
| ***Vachellia jacquemontii*** | ***Vachellia leucophloea*** | ***Vachellia nilotica* subsp. *indica*** |
|  |  |  |
| ***Vachellia tortilis*** | ***Vallaris solanacea*** | ***Ventilago denticulata*** |

**Plate 53**



*Vincetoxicum spirale*



*Viscum loranthi*

*Vitex negundo*

*Vitex peduncularis*

*Vitis vinifera*

*Volkameria inermis*

*Wendlandia heynei*

*Withania somnifera*

*Woodfordia fruticosa*

**Plate 54**

|  |  |  |
|---|---|---|
| ***Wrightia arborea*** | ***Wrightia tinctoria*** | ***Xanthium strumarium*** |
|  |  |  |
| ***Xylosma longifolia*** | ***Zanthoxylum armatum*** | ***Ziziphus glaberrima*** |

|  |  |  |  |
|---|---|---|---|
| ***Ziziphus jujuba*** | ***Ziziphus nummularia*** | ***Ziziphus oenoplia*** | ***Ziziphus xylopyrus*** |

## 4. Discussion

From the total study region in the state, 512 ligneous (woody) species from 342 genera and 84 families (81 angiospermic and 3 gymnospermic) were reported. Fabaceae (96 species), Malvaceae (37 species), Apocynaceae (25 species), Moraceae and Rubiaceae (17 species each), and Moraceae & Euphorbiaceae (6 species each) were the six largest families in the region. *Ficus* is the largest genus (10 species), followed by *Terminalia* (9 species), *Grewia* (9 species), *Senna* (8 species), *Ipomoea* (7 species), *Solanum* (7 species), and *Vachellia* (6 species). Of the 512 species that have been identified, 365 are native, 126 are planted, and 19 are considered invasive. Table 1 contains all the necessary and pertinent information on the plant species that were collected, and excellent 54 photo plates show the images of the Haryana species that were photographed, arranged alphabetically (Photo plates 1-54).

## 5. Conclusion

For biodiversity to be used sustainably, regular monitoring is essential. In addition to helping forest officials' inventory and tracking the floristic riches of their forest resources, the forest flora also helps policymakers create efficient plans for the wise use of Haryana's floristic wealth. The current study offers a thorough overview of the state's forest flora, including both native and cultivated species. This photographic inventory of Haryana's forest flora will be extremely helpful to researchers, academics, the state biodiversity board, forest officials, and others who are involved in different aspects of the state's flora.

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## Author's Contribution

PKV conducted the major field work and wrote the original draft of the paper. NS helped in survey and help in drafting, while SK helped in tabulation of data. Additionally, AC and RN were involved in the manuscript preparation. All authors have read and agreed to the final version of the manuscript.

## Data Availability

All data generated or analyzed during this study are included in this published article

## Conflicts of interest

Authors state that there is no conflict of interest.

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