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## **Exploring the Therapeutic Potential of Phytochemicals and Pharmacological Properties of Medicinal Flora in Uttarakhand: A Review**

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10.48047/AFJBS.6.Si3.2024.2788-2799**Abstract**

Medicinal plants have been an important part of ancient health care systems for centuries, and is offering a widespread range of medicinal benefits with less or zero side effects. Uttarakhand, a Himalayan state in India, is gifted with a rich biodiversity of native flora, boasting a diverse array of medicinal herbs with vast potential for treating several ailments. This comprehensive review explores the therapeutic potential of important selected plant species, focusing on their active components and therapeutic properties. The study highlights the antidiabetic, antimicrobial, antioxidant, and other helpful activities showed by the bioactive compounds synthesized by these plants. The key findings of this review emphasize the urgent need for further research to identify and illustrate the specific bioactive components responsible for the therapeutic effects, as well as to assess their clinical success through rigorous scientific studies. The important selected plant species shows an auspicious potential because of their high biologically active components in them which contribute to their valuable properties. However, the review also underlines the threats faced by these medicinal floras, including deforestation, urbanization, and uncontrolled tourism, which could lead to the loss of this precious natural resource and the native knowledge linked with it. The study not only highlights the medicinal importance of plants in Uttarakhand but also stresses the serious necessity for conservation efforts to reserve this rich biodiversity and traditional knowledge of Uttarakhand. Further investigation and ranking of these medicinal plants based on their efficacy could cover the way for the expansion of safer and more effective medications, ultimately contributing to worldwide health benefits.

**Keywords:**Antioxidant, bioactive compounds, diseases, medicinal plants, phytochemicals, therapeutic, Uttarakhand

**1. Introduction**

Medicinal plants have been in use since ancient times and remain an imperative aspect of traditional medicine systems around the world. These plants, with their diverse chemical structures, provide a multitude of medicinal properties that have been used for many diseases. Throughout history, different cultures have relied on medicinal plants to treat diseases. Early civilizations such as AYUSH, and Chinese have documented the use of herbs for medicinal purposes in their writings and practices. This ancient knowledge forms the foundation of current research on the therapeutic properties of plants. Medicinal plants cover a wide range of botanical species, including herbs, bushes, trees, and even some fungi. Each plant species contains a unique combination of bioactive compounds, such as flavonoids, alkaloids, terpenoids and phenolics, that contribute to their medicinal properties. Medicinal plants find applications in both traditional and modern medicine for the prevention and treatment of abundant disorders. From common colds to chronic diseases like diabetes and cancer, plant-derived remedies offer substitute or adjunctive therapies with potentially less side effects compared to synthetic drugs. The World Conservation Monitoring Centre (WCMC) recognized India as a mega-diversity country in 2000. The country covers an area of nearly 329 million hectares, which is made up of forests, grasslands and wetlands, coastal areas, marine areas and desert areas.

The country India comprises 2.4% of the total land area on this planet. The total number of species of angiosperms, bryophytes, pteridophytes, gymnosperms found in India is 268600, 16236, 12000 and 1021 respectively (Chapman, 2006) [13]. Pharmaceutical companies in India use around 280 different medicinal plants from 79 different families to make different types of medicines used for Ayurveda, homeopathy, and even allopathic medicine. Approximately 175 of these medicinal plants are found in the Indian Himalayan region (Dhar *et. al.*, 2000) [17]. In India, ethnomedicinal plants, as a category, encompass around 8000 species and constitute approximately 50 percent of the total number of higher blooming floral species (Gaur and Tiwari, 1987; Uniyal, 1977) [19, 56].

India including more than 100 species that are widely employed in traditional medical practices across the world and is well-known for its excellent grade and availability of therapeutic plants, it ranks 2nd in the world in medicinal plant exports. It is one of the earth's twelve major ecological zones, with 16 climate-sensitive regions and an estimated 45,000 species, 7000 of which are classed as remedial herbs (Chakraborty, 2018) [11]. According to World Health Organization (WHO), 80 percent of the global population depends on herbal medicines as their primary source of essential healthcare, with a significant portion of this therapy involves the utilization of plant extraction and bioactive compounds (Craig, 1999) [16]. Traditional herbal practitioners in rural parts of India continue to practice traditional herbal therapy, which uses over 2500

herbs to cure important diseases and has been accepted as one of the most successful methods in Indian medicine (Parvej *et al.*, 2019) [44].

Uttarakhand also termed as “Devbhoomi”, is well-known for its widespread therapeutic herbal supplies. State’s meteorological, geographical and loam variation have led to the proliferation of numerous valuable and economically significant species of medicinal plants, that have significant medicinal value. Significant variety of medicinal plants that treat a wide range of ailments and have been utilized by the pharmaceutical industry in the manufacturing of medicines utilized by the Indian System of Medicine (Kumar *et al.*, 2018) [30]. Herbal medicines have a long history of being used to deal with the activity of a lot of medical conditions. The continuous usage of such medicines has had profound effects for modern healthcare system (Chen *et al.*, 2014) [14]. The pharmaceutical industry has traditionally depended mostly on large-scale screening of drugs and inorganic compounds for the discovery of new medicines due to the complexity of natural product-based databases and inorganic compound collections. However, such an approach has helped to slow the release of new pharmaceuticals onto the market, necessity the certain wide, multidisciplinary methodologies for the creation of new medicines based on natural ingredients (Atanasov *et al.*, 2015) [7].

Plants contain abundant amounts of antioxidants, which protect against diseases related to free radicals (Lawal *et al.*, 2017; Ofoeduet. *al.*, 2022) [33, 42]. Antioxidant compounds are typically formed in plants as secondary metabolites. Phytochemicals are non-nutritional chemical compounds from plants that provides a variety of health benefits and disease-fighting properties (Coulibaly *et al.*, 2014) [15]. The nutrients present in them are not essential for human life, that is, the body does not need them to maintain life (Rahim *et al.*, 2022) [47]. There are over a thousand phytochemicals that are classified as primary or secondary components based on their participation in plant metabolism (Mahantesh *et al.*, 2012) [38]. Primary constituents of phytochemicals include the fundamental sugars, amino acids, chlorophylls, as well as nucleic acids, purines, pyrimidines and proteins (Akram *et al.*, 2014) [5]. In addition to the chemicals previously listed, secondary components include the following chemicals: Alkaloids; flavonoids; terpenes; Phenolics; Lignan; Plant steroids; Curcumin saponins; and Glucosides (Awuchi and Twinomuhwezi, 2021; Zahnit *et al.*, 2022) [8, 61], of these, the most common are phenolic compounds making up 45% of the plant's secondary phytochemicals, followed by terpenoids and steroids making up twenty seven percent, alkali compounds making up eighteen percent, and others making up ten percent (Prakash *et al.*, 2011) [46]. The function of phytochemicals is diverse (Karamacet. *al.*, 2019) [29] and they have distinct pharmacological properties. Some of these properties are; antioxidants, anti-bacterial, antifungals, chemo preventive, neuroprotective anti-inflammatory, anti-plasmodic, anti-allergic, hypotensive, antiaging, and so on (Park *et al.*, 2019) [43]. Aside from boosting the immune system and preventing the formation of carcinogens, they also regulate hormones like estrogen and insulin, high levels of which have been linked to an increased risk of breast and colon cancer, as well as oxidation, inflammation and DNA damage. They also slow down the growth rate of cancer cells (Morya *et al.*, 2022) [40].

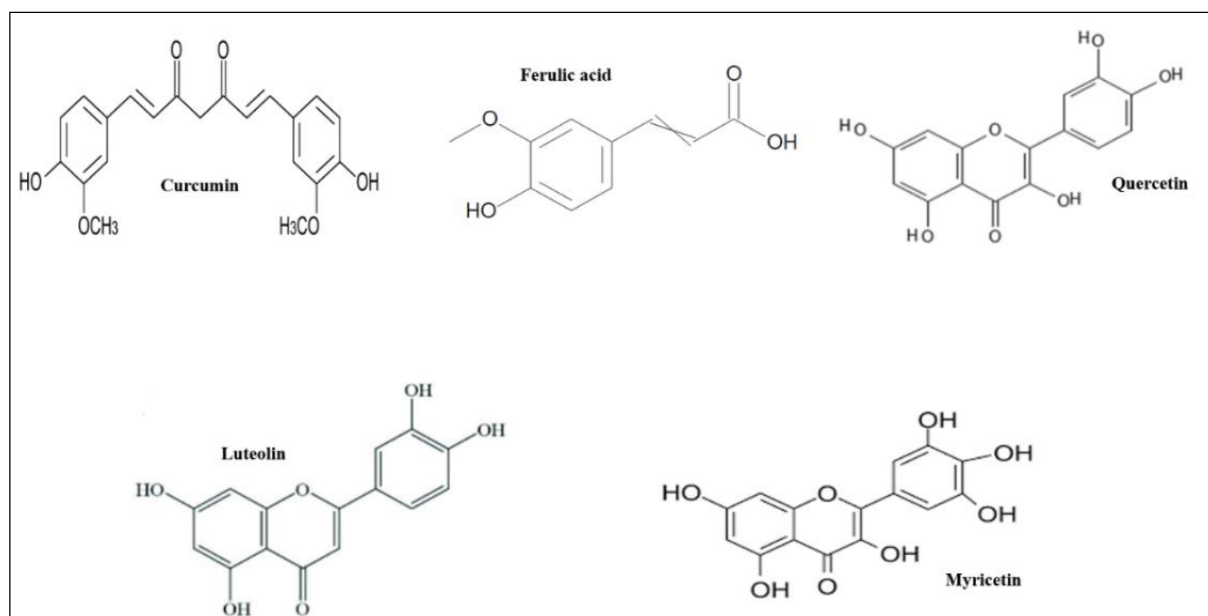
The scientific literature has witnessed an increase in the number of papers on efficacy evaluation of medicinal plants, which have contributed significantly to the protection of health through various mechanisms. Despite this commendable progress, there is still lack of comprehensive information on updated compilation of promising medicinal plants from various plant species (Singh *et al.*, 2012; Kumar and Joshu, 2020) [50, 31]. Though several medicinal plants are used in Uttarakhand, and many of them have been investigated for their potential as phytochemical properties or sources of pharmaceutical components. Based on information gathered from a variety of important literature sources, this review presents a list of some important medicinal plants found in Uttarakhand that have different therapeutic properties and traditional uses.

## Methodology

The review adopted a systematic approach to identify relevant literature related to indigenous medicinal plants of Uttarakhand. A comprehensive search was conducted in various electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar, using a series of relevant keywords such as “medicinal plants”, “Uttarakhand”, “phytochemical analysis” “medicinal properties”, and “traditional uses” to be done. Particularly, the search was not constrained by publication date but priority was given to studies published within the last two decades to include present-day research findings. Peer-reviewed journals, books and relevant literature were considered. Data extraction was carefully performed using a standardized format to ensure consistency and precision, including scientific and vernacular names of plants, plant parts used, identified phytochemical components, medicinal activities evaluated, and essential details such as key outcomes were included. Synthesis and analysis of the extracted data facilitated a comprehensive investigation of the therapeutic efficacy of medicinal plants of Uttarakhand, elucidating general trends and patterns. Ethical considerations follow established guidelines for literature reviews, with no involvement of human or animal subjects requiring ethical approval.

## The therapeutic potential of phytochemicals

It is widely accepted that about 80 percent of earth's people relies on therapeutic remedies, for example antidiabetic: quinine, allicin, artemisinin, antimalarial; analgesic: morphine, codeine; cardiac depressant: quinidine; and for brain functions: nicotine and caffeine (Kamboj, 2000) [28], some chemical structures of bioactive compounds are shown by Figure 1. The amount and quality of the active component will often vary with the secondary metabolites depending on the plant's geographic location. Plant metabolites can be divided into two categories: Primary and secondary metabolites. All living cells consist of primary metabolites like amino acids, glucose, nucleic acids, polysaccharides, proteins etc., and are helpful in the growth and development of a plant cell, whereas, major secondary products originate from primary metabolites which doesn't support growth. There are three main categories of plant metabolites: terpenoids, alkaloids and phenols, as terpenoids are the most extensive groups of plant metabolite, comprising over forty thousand compounds, whereas phenols, with just eight-thousand are the smallest (Vishwanathan and Basavaraju, 2010) [57].



**FIGURE 1: CHEMICAL STRUCTURES OF SOME BIOACTIVE COMPOUNDS.**

Given the diverse array of biotic resultants exhibited by specialized metabolites, they have found extensive application in folk medicines (Hussein and Anssary, 2019) [21]. The inhibition of bacteria, fungi, protozoan, and other microorganisms has been demonstrated by a number of sesquiterpene lactones. Gallic acid is a simple phenolic compound, is particularly well known for its antifungal and antibacterial properties, as well as its antiviral and antitumor properties. Further, gallic acid has been found to have anti-inflammatory and anti-anaphylactic, choleric and broncho dilatory actions. The derivatives of the flavonoid component curcumin shown strong antifungal action (Mazid *et. al.*, 2011) [39]. The rubefacient effects, circulatory stimulation, and analgesic activities attributed to capsaicin are primarily due to the presence of capsaicinoids (Ahmed *et. al.*, 2017) [3]. Because of the increased requirements from the medicament and food industries, the presence of antioxidant properties has resulted in the development of new food preservatives to replace the natural ones as well as new treatments for various kinds of infections to fight microbial resistance to traditional antibiotics.

## 2.1. Curcumin

It derived primarily from the rhizome of the turmeric plant; this bioactive polyphenolic compound is one of the most important. This compound is famous for its anti-bacterial, antioxidant as well as anti-carcinogenic properties. Several researchers have found that curcumin may be effective in the prevention of gastric cancer. When given orally, curcumin significantly reduced carcinogenesis and tumor growth in animal models of gastric cancer (Spiller *et. al.*, 2008) [52].

## 2.2. Ferulic acid

Ferulic acid (FA), a naturally occurring phenolic molecule, is widely present in herbal plants and has a variety of health benefits, including the ability to reduce inflammation, act as an antioxidant, fight cancer, and treat diabetes (Jakubek *et. al.*, 2019; Phuengmaunget. *al.*, 2019) [24, 45]. It is interesting that FA has both prooxidative and antioxidant properties, in addition to exhibiting a wide variety of antibacterial actions against all pathogens (Yin *et. al.*, 2019) [60]. Folic acid plays an important role in safe-guarding the male reproductive system from the harmful effects of arsenic exposure, reducing the likelihood of testicular damage, and reducing oxidative stress (Guvvalaet. *al.*, 2019; Ibitoye and Ajiboye, 2019) [20, 22].

### 2.3. Quercetin

The flavonoid, quercetin, is a naturally occurring bioactive compound present in a various food, particularly veggies and fruit. Commonly found in apple, grape, raspberry, cabbage, and nut products. Its position is based on its ability to inhibit metastasis, to trigger apoptosis, and its remarkable anticancer and immunomodulatory properties (Guvvala *et. al.*, 2019) [20]. Previous study has suggested that the use of quercetins might have the potential to inhibit the progression of degenerative diseases due to its biologic and pharmacological properties, including those associated with dermatitis, renal fibrosis and myocarditis, as well as neurodegenerative diseases, cardiovascular and cancer conditions (Lan *et. al.*, 2019) [32].

### 2.4. Luteolin

Luteolin (also called as luteolin flavonoids) is a flavonoid found in several plants, including broccoli, celery, peppers, and thyme. It shows anti-cancer efficacy by activating the p-53 (protease factor-53) receptor and stimulating the autophagy process in HCC (hematologic carcinoma) cells (Jia *et. al.*, 2019) [25]. Luteolin has been documented to have a wide range of medicinal and biological properties, including its antioxidant, anti-cancer, and anti-diabetic properties. The results demonstrate that the natural compound of luteolin facilitates cell-dependent apoptosis of Eca-109 cancer cells, which is mediated by caspase-3 and caspase-9 mRNAs and protein expression (Lee and Kwon, 2019) [34].

### 2.5. Myricetin

Myricetin is a naturally occurring flavonoid which is found in numerous vegetables, fruits, and tea. It is well recognized for its prevailing antioxidant properties, which help neutralize free radicals and reduce oxidative stress in the body. Myricetin also has anti-inflammatory effects, which contributes to the prevention of enduring ailments such as heart disease and cancer. As well, it has shown the capability to improve cognitive function and protect against neurodegenerative disorders. Several studies show that myricetin may help control blood sugar levels also and making it beneficial in the treatment of diabetes. In total, this compound holds promise for many therapeutic applications due to its diverse biological activities (Wang *et. al.*, 2019) [58].

### Practices of some important medicinal plants: Uttarakhand

Traditional medical systems worldwide heavily rely on medicinal plants like *Mimosa pudica*, known for their diverse medicinal properties. Both the roots and leaves of *Mimosa pudica* have demonstrated significant efficacy against diabetes, liver diseases, cancer, and wound healing, along with treating conditions such as urogenital disorders, hemorrhoids, dysentery, and sinus issues (Arpan *et al.*, 2022). Uttarakhand, India, is rich in such medicinal herbs, as depicted in Figure 2. Recently, there has been a surge in interest in plant-based biochemistry, driven by factors like the increasing demand for therapeutic solutions, the use of new biologically active organic compounds as biogenic probes, and the development of innovative techniques to isolate, purify, and characterize these compounds (Jiang *et al.*, 2019) [26]. This review aims to assess the pharmacological and therapeutic properties of specific medicinal plants native to the Uttarakhand region.



FIGURE2:SOME IMPORTANT MEDICINAL PLANTS OF UTTARAKHAND

- *Acorus calamus L.* is a member of the Aceraceae family and is commonly referred to as Baj. The root of this plant has been linked to the relief of headaches. Furthermore, research has shown that it has properties that can fight parasites and bacteria. Extracts obtained from *Acorus calamus* have confirmed their efficiency in treating various ailments including fever, bronchitis, asthma, cough, and numerous digestive disorders.
- *Aegle marmelos* also called as Bel, is a plant species from the Rutaceae family. Various studies have verified that the fruits and leaves of this plant possess antidiarrhea, astringence, anti-dyestradiol and anti-pyretic properties. The fruit shows a wide range of therapeutic benefits, such as the ability to scavenge free radicals, act as an antioxidant, prevent lipid peroxidation, provide antibacterial and antiviral properties, reduce diarrhea, protect the gastrointestinal system, manage diabetes, protect the heart and provide radiation protection.
- *Aconitum heterophyllum* belongs to the family Ranunculaceae. The leaves powder of *Ajuga Parviflora* and the root powder of *Podophyllumhexandrum* are mixed together with the powder of *Aconitum heterophyllum* to treat diabetes and leukorrhea. Ash, oleic, palmitic, and stearic glycerides, as well as aconitic acid, aconitine, and tannic acid, are found in this plant species.
- *Boenninghauseniaalbiflora* is a member of the Rutaceae family, which is commonly referred to as "Pissumar". Extracts from this plant are used externally to treat head or eye pain. Several studies have demonstrated its anti-inflammatory, immunomodulating, and hepatoprotective properties, as well as its antioxidative properties.
- *Bergeniaciliata*(Haw.) Sternb. belongs to the family Saxifragaceae. The root is soaked in mustard oil overnight, and the resulting root extract is applied to the hair to serve as a tonic, enhancing hair shine. A decoction of the root is used to treat coughs, colds, liver problems, stomach conditions, asthma, piles and is additionally used as a tonic.
- *Cydonia Oblonga* is a plant species native to the Indian state of Uttarakhand, which is part of the Rosaceae family and is commonly referred to as "Bihi" in the local area. There have been reports of the presence of phenolic component in the leaves, which are responsible for its antioxidant properties, as well as Vitamin-E and carotenoids. Also, it contains a variety of organic acids. In the state, there is a long tradition of using this plant to treat some derma conditions, as well as for its anti-retroviral, and antiseptic properties.
- *Datura stramonium* and *Daturametel*, both are the members of Solanaceae family, and commonly known as Datura in specific regions of India. Reports suggest that the leaves of these plants are used in a variety of ways due to their versatile properties, which include anti-asthma, anti-bacterial, analgesic, antibiotic and antimicrobial properties.
- *Geranium wallichianum* is a part of the family Geraniaceae. The root sap is filtered and applied to the eyes and ears to treat earache and eye ailments, as well as to enhance visual insight. The root paste is administered for stomach disorders. The plant contains tannins, starch, glucosides, pectin's and sugar.
- *Julansregia L.* Vern. Akhod belongs to the family Juglandaceae. The twigs are used as toothbrushes, to treat toothache and for diarrhea. A paste is made by mixing the pericarp of the drupe, immature leaves of *Lyoniaovalifolia* and cow's urea. This mixture is used apparently to treat atopic dermatitis and psoriasis. It is worth noting that the fruits of *Julans* contain oxalic acid, while the seeds of the plant produce fixed oil and juglandic acids, as well as a resin.
- *Polygonatumcirrhifolium* is a member of the Asparagaceae family, commonly referred to as Mahameda. Its root extract is utilized for a variety of purposes, including anti-inflammatory, antibacterial, antioxidant, anti-malarial, and analgesic values.
- *Podophyllumhexandrum*Royle, is a member of family Podophyllaceae Vern. Shon kakadi. Root powder with *Ajuga parviflora* given to treat diabetes and fever, while the paste made from these roots is applied externally, on cuts and various skin diseases. Rhizome powder is used as a carminative and in the treatment of biliary problems. The plant is rich in podophyllin, podophyllotoxin and its roots contain significant amounts of resin. The rhizome yields podophyllum, a sticky resin along with quercetin and podophyllotoxin.
- *Thymus linearis* Benth. Vern. Marchyaghash which is a member of family lamiaceae. The entire plant is grounded into a fine powder and administered in roughly half a teaspoon to address issues with weak vision and menstrual irregularities. To alleviate eczema and psoriasis, a paste made from powdered thyme leaves and honey is used as an external application. Thyme boasts a composition of 0.15-0.6% volatile oil, which includes components like phenols, thymol, terpene, alcohol, tannin, and resin.
- *Verbascumthapsus L.*, is a member of family Scrophulariaceae. The root of the plant is used to treat bronchitis, asthma, and other respiratory conditions. Entire plant is rubbed on the tongue to treat excessive growth, which is locally referred to as "daudjeeb". Furthermore, the leaf paste and cow's urine are applied externally to the affected area to treat

boils, a type of inflammation. The roots of the plant contain a variety of chemical substances like saponins, volatile oils, tannins, and wax.

## Discussion

The modern states of Uttarakhand are located in the central region of the Himalayan Mountain range, which is rich in therapeutic herbs. The gradual degradation and extinction of indigenous knowledge about therapeutic herbs around the earth is a significant concern, as it represents the loss of valuable cultural heritage in rural communities. Anciently available medicinal herbs are intended to provide an alternative health care options for regional communities with limited financial resources. Medicinal plants consist of various phytochemicals and have demonstrated their effectiveness in treating different sickness including cough, diabetes, anemia, mental disorders, microbial infections, etc. (Elujoba *et. al.*, 2005) [18], which is shown in Table 1. There could be various factors for the decline of traditional herbal treatments, the over-replacement of traditional medications with allopathic drugs has been widely attributed (Singh *et. al.*, 2012) [50]. To gain a more detailed comprehension of the current state's indigenous medical system, future studies on the general level of proficiency in the subject can benefit from the findings. In recent years, the rural population has been rapidly depopulating and the cultural and socio-economic values of the locals have rapidly changed. If this is not addressed, a significant portion of the essential profession of medicine will be lost in a short period of time. Therefore, it is essential to devise a plan to preserve, document, and disseminate therapeutic and pharmacological knowledge regarding medicinal plants.

**TABLE1: LIST OF SOME IMPORTANT MEDICINAL PLANTS SHOWING BIOLOGICAL PROPERTIES AND PHYTOCHEMICAL CONSTITUENTS**

Botanical name	Common name	Family	Part used	Phytochemicals constituents	Therapeutic uses	Ref.
<i>Acorus calamus L</i>	Baj, sweet flag	Acoraceae	Leaves, root and stem	Glycosides, flavonoid, saponins, tannins, polyphenolic compounds	Fever, asthma, bronchitis, cough,	Chandra and Prasad, 2017[12]
<i>Aegle marmelos</i>	Bel	Rutaceae	Leaf, fruit	Carotenoid, phenol, alkaloid, pectin, tannins, coumarin, flavonoid, terpenoid	Diarrhea, dysentery, peptic ulcers	Rahman and Parvin, 2014[48]
<i>Aconitum heterophyllum</i>	Ativisha	Ranunculaceae	Roots	Diterpenoids, alkaloid, flavonoid, kaempferol, glycoside	Coughs, diarrhea, indigestion	Wani <i>et. al.</i> , 2022[59]
<i>Boenninghausenia albiflora</i>	Pissumar	Rutaceae	Leaves, roots	Cinnamyl propyl, cinnamyl aldehyde, cinnamyl alcohol	Cuts, wounds, malaria, headache	Tandon and Mittal, 2018[54]
<i>Butea monosperma</i>	Dhak or Palash	Fabaceae	Seeds, leaves	Flavonoids, lactone, diterpenoid, diterpene, glycoside, phytosterols	Fever, chest pain, earache, piles, skin problems	Lohitha <i>et. al.</i> , 2010[35]
<i>Bergenia ciliata</i>	Winter begonia	Saxifragaceae	Roots, leaves	Polyphenol, phenol, glycoside, lactones, quinones, sterols, tannin, terpene	Kidney stones, diarrhea, vomiting, diabetes	Ahmad <i>et. al.</i> , 2018[2]; Byahattiet. <i>al.</i> , 2010[10]
<i>Cydonia Oblonga</i>	Bihi, common quince	Rosaceae	Seeds, fruit, leaves	Phenols, steroids, flavonoids, terpenoids, tannins, glycosides	Cancer, diabetes, ulcer, urinary infections	Ashraf <i>et. al.</i> , 2016[6]
<i>Datura stramonium and Daturametel</i>	Datura, nightshade	Solanaceae	Leaves, seeds, fruit	Tropane alkaloids, hyoscyamine	Stomach pain, toothache, fever, dandruff, hair fall	Islam <i>et. al.</i> , 2023[23];

						Soni <i>et. al.</i> , 2012[51]
<i>Geranium wallichianum</i>	Cranesbill	Geraniaceae	Roots, bark, whole plant	Flavonoids, phenols, terpenoids, saponins, tannins	Rheumatism, leucorrhea, arthritis, gonorrhoea	Abbasi <i>et. al.</i> , 2019[1]
<i>Juliansregia L.</i>	Akhrot, walnut	Juglandaceae	Fruit, bark, leaves, flower	Alkaloids, flavonoids, polyphenols	Helminthiasis, diarrhea, arthritis, thyroid, asthma	Bourais <i>et. al.</i> , 2022[9]
<i>Melia azedarach</i>	Chinaberry, ghoraneem	Meliaceae	Roots, leaves, fruit	Alkaloids, astringents, antioxidants, aromatic chemicals, flavanols	Acne, burns, measles, bleeding gums, ulcer	Shreshtha <i>et. al.</i> , 2021[49]
<i>Polygonatumverticillatum (L.)</i>	Mahameda	Asparagaceae	Fruits, leaves, rhizomes	Alkaloids, amino acid, fatty acid, carbohydrate, flavonoids, phenols, tannins, steroids	Wounds, ulcer, fever, cough	Suyal <i>et. al.</i> , 2019[53]
<i>PodophyllumhexandrumRoyle</i>	Himalayan mayapple	Berberidaceae	Rhizomes, leaves	Podophyllotoxin, glycosides, flavonoids, saponins	Cancer, liver disorders, jaundice, lymph glands	Lone <i>et. al.</i> , 2023[36]
<i>Rhododendron arboreum</i>	Burans	Ericaceae	Flowers, bark, roots, leaves	Flavonoids, sterol, triterpenoid	Feaver, diarrhea, cancer, diabetes	Som <i>et. al.</i> , 2019
<i>Tinospora cordifolia</i>	Gilloy	Menispermaceae	Stem, roots, whole plant	Tinosporin, Terpenoids, Alkaloids (Octadecenoic acid, gamma. -Sitosterol, n-Hexadecanoic acid)	Diabetes, fever, jaundice, immunity booster	Akhilraj <i>et. al.</i> , 2024[4]
<i>Thymus linearis Benth</i>	Jungle ajwain,	Lamiaceae	Leaves, roots	Flavonoids, phenols, thymol, terpinene, p-cymene	Obesity, diabetes	Kabda <i>et. al.</i> , 2022[27]
<i>Verbascumthapsus L.</i>	Mullein	Scrophulariaceae	Leaves, roots	Polysaccharides, glycosides, flavonoids, saponins	Pulmonary problems, asthma, cough, diarrhea, inflammation	Panchal <i>et. al.</i> , 2022

## CONCLUSION

The present study on medicinal herbal plants can serve as a valuable resource for classifying a specific collection of plants that exhibit efficacy in combating a particular ailment, or for illustrating the diverse clinical advantages associated with a given plant. In particular, there has been a lack of in-depth study into the clinical efficacy of widely used medicinal plants related to their specific plant components, selected phytochemicals, and the potential relationship between phytochemicals and various clinical applications. Phytochemicals are certainly an important natural resource for future drug discoveries. However, only a small fraction of the phytochemical characteristics of medicinal plants have yet to be studied. The study as a whole comes to the conclusion that the plants studied are full of medicinal and pharmacological importance since, they have been found to be rich in phytochemicals. This study examined the primary biological characteristics of a variety of medicinal plants in order to gain an understanding of their therapeutic applications and potential antioxidant characteristics. The general biological characteristics and uses of the plants, particularly their antioxidant properties, were extensively studied. These plants are characterized by their high phenolic content and flavonoids. Currently, these plants are facing threats due to construction practices, increasing population pressure, impact of tourism, deforestation and other factors, all of which have an impact on the local environment, ecology and cultural heritage. This presented study not only highlights the benefit of specific medicated flora found in Uttarakhand, but also, it contributes to the conservation of indigenous classical knowledge and medicinal insights. It is necessary to conduct a comprehensive study on these types of



antioxidant plants so that they can be ranked according to their antioxidant capacity. Ultimately, the development of more efficient and safer drugs will be beneficial to the global population.

### Conflict of interest

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

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