



Evaluation of ethnopharmacologically selected Indian medicinal plants for their classes of Phytochemical and biological activities

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Abstract The ethnomedicinal values of plants form the basis of the herbal drug industry. India has contributed its knowledge of traditional system medicines (Ayurveda and Siddha) to develop herbal medicines with negligible side effects. The World Health Organization has also recognized the benefits of drugs developed from natural products. *Abutilon indicum*, *Hibiscus sabdariffa*, *Sida acuta* and *Sida rhombifolia* are ethnomedicinal plants of Malvaceae, commonly used in Indian traditional system of medicines. Traditionally, these plants were used in the form of extracts/powders/pastes by tribal populations of India for treating common ailments like cough and colds, fever, stomach, kidney and liver disorders, pain, inflammation, wounds, etc. The present review is an overview of phytochemistry and ethnopharmacological studies that support many of the traditional ethnomedicinal uses of these plants. Many phytoconstituents have been isolated from the four ethnomedicinal plants and some of them have shown pharmacological activities that have been demonstrated by *in vivo* and/or *in vitro* experiments. Ethnomedicinal uses, supported by scientific evidences is essential for ensuring safe and effective utilization of herbal medicines.

Keywords Ethnomedicinal plants, *Solanum xanthocarpum*, *Adhatoda vasica*, *Ocimum sanctum*, Phytoconstituents

1. Introduction

Plants have fulfilled humans' requirements for shelter, clothing, sustenance, tastes, scents, and, notably, medicinal purposes. Many of the world's ancient medical practices, including Ayurveda from the Indus civilization, Mesopotamian Arabian medicine, Chinese and Tibetan medicine from the Yellow River civilization, and Japanese Kempo, primarily rely on using plants for healing purposes. The ancient civilizations are famous for their organized gathering of knowledge about plants, particularly herbs, and their extensive and carefully-documented compendiums of herbal medicines. Despite the fact that certain claimed healing properties of plants have been proven false, the utilization of medicinal plants for therapy is grounded in the observed experiences and knowledge gained over countless years.

The use of herbal medicines derived from traditional medicinal plants has become increasingly significant not just in India but globally. The indigenous wisdom of Indian medicine has been transferred across generations, primarily within certain regions or tribal communities. This ancient wisdom originates from traditional Indian systems of healing, such as Ayurveda and Siddha, and is increasingly becoming appreciated in the Western world as well. Ethnomedicines or herbal medicines have gained popularity due to their affordability and minimal adverse reactions. The significance of traditional medicine in the healthcare industry has been acknowledged by the World Health



Organization (WHO) in recent times. In Ayurveda and Siddha systems of medicine, remedies are created using specific parts of plants and are employed in the treatment of different illnesses. For nearly 30 years, there has been scientific research conducted on numerous traditional medicinal plants cited in Ayurveda and Siddha medical systems. The scientific assessment of traditional medicinal plants offers validated alternative medicines, serving as the foundation for the herbal drug sector and the identification of therapeutic targets in the pharmaceutical industry. It is important to note that the utilization of ethnomedicinal plants in traditional medicine or in the production of Ayurvedic medicines and other herbal drugs, with the backing of scientific evidence, can lead to the safe and more efficient use of natural medicines worldwide.

Some scientific studies provide partial support for this claim. The medicinal characteristics found in plants are primarily caused by secondary compounds. These compounds are necessary for plants to thrive in their natural habitats when they face specific stresses and competition. These properties might not be readily observable in plants that are cultivated in a controlled, uniform environment. The active ingredient concentrations in fast-growing cultivated stocks can be significantly lower compared to wild populations, which grow slowly and may have higher active ingredient levels due to their age.

The common tradition of using herbal remedies has been passed down through the ages and includes treatment for both minor and severe illnesses. A medicinal plant is a type of plant that contains active chemicals such as alkaloids, glycosides, saponins, essential oils, tannins, and mucilages in different parts like the root, stem, leaves, bark, fruit, and seed. These chemicals have the ability to produce a specific healing effect in the treatment of various diseases in both humans and other animals. For thousands of years, plants with healing properties have been utilized in nearly every society. These plants have served as a means of generating income and providing accessible healthcare for the population. Around the globe, approximately 53,000 types of plants are utilized for their medicinal properties. According to the World Health Organization, approximately 70 to 95% of individuals in developing nations primarily depend on medicinal plants for their primary healthcare requirements. Moreover, the sale of these plants contributes to 15 to 30% of the overall income for poorer households. India possesses the largest quantity of medicinal plants that are cultivated and naturally grown. According to, there are more than 15,000 species utilized for various health care systems in Asia. Specifically, China is home to 7,000 species while India boasts 8,000 species. Medicinal plants hold immense importance in the livelihoods of people, particularly those residing in the mid-altitude and highland regions, as stated by Sati in 2013. Approximately 65% of people in India rely on the conventional approach to healthcare.

According to reports from the World Health Organization, over 80% of the global population depends on plant extracts for primary-level disease treatment. In Asian nations, the utilization of natural remedies is widespread. Illustrates a broad account of the interactions between humans and plants throughout history. Medicinal plants, which are utilized in traditional medicine, consist of a wide variety of bioactive substances capable of being utilized for different purposes. Treat both long-term and contagious illnesses. According to reports from the World Health Organization, over 80% of the global population depends on plant extracts as a primary means of treating illnesses. The extensive history of human and plant interactions is illustrated by the utilization of herbal medicines in Asian countries. Plants with medicinal properties, which are utilized in traditional medicine, have a wide variety of biologically active compounds that have the potential to treat both chronic and infectious illnesses.

2. Ethnomedicinal Uses

2.1 *Solanum xanthocarpum* Schrad & Wendl. (Solanaceae)

Kantkari is the common name for the annual herbaceous plant *Solanum xanthocarpum*, which belongs to the Solanaceae family. It is referred to as a medicine for the treatment of bronchitis and asthma in Ayurveda. According to Singh and Singh (2010), the berry juice can help soothe sore throats. *S. xanthocarpum* has been extensively employed in the Siddha system of medicine, mostly in southern India, to treat respiratory illnesses. The varied PFT parameters in asthmatic participants were improved by treatment with *S. xanthocarpum* whole plant powder (Govindan et al., 1999, 2004). Additionally, in a rat bronchial asthma trial, an aqueous standardised extract of *S. xanthocarpum* was found to exhibit anti-inflammatory, immunomodulatory, and antioxidant properties.



In Ayurveda, *Solanum xanthocarpum* makes up a significant portion of Dasmoola. Dasmoola is the name for a ten-plant root combination that includes the roots of five large or important trees (Brihat panchmoola) and the roots of many smaller or less significant plants (Laghu panchmoola).

It is a prickly plant that grows next to roadways and in open spaces. The branches are dispersed throughout the ground and are between two and three metres high. The cymes-shaped, bluish-violet blooms. It is a plant that is safe to use and is not poisonous. *Solanum xanthocarpum* is important in a variety of medical contexts. The Ayurvedic herb's roots, leaves, branches, and blossoms are all beneficial components. The various components of the plant are used to cure a variety of ailments, including kidney and bladder stones, fever, coughs, colds, and coughs with fever. The fruit paste is renowned for treating edema and zits.



Figure 1: *Solanum xanthocarpum* aerial parts

2.2. *Adhatoda vasica* Nees (Acanthaceae)

Adhatoda vasica (L.), Nees is a shrub with opposing ascending branches that belongs to the acanthaceae family. Since around 2500 years ago, the plant has been utilised in India's traditional medical system. The plant is widely used in Ayurvedic and Unani medicine as a medication. It has a long history of usage for the treatment of many acute and chronic illnesses, and studies have shown that it is particularly effective for bacterial infections, coughs, bronchial infections, reproductive abnormalities, heart ailments, and many other conditions. *Adhatoda vasica* (*A. vasica*) was used to extract a number of phytochemicals, including alkaloids, flavonoids, tannins, etc. The plant's active ingredient is vasicine, also known as l-vasicinone, deoxyvasicine, maiontone, vasicinolone, and vasicinol, among other compounds. This study includes new data on the phyto-constituents that were extracted from *A. vasica* and their prospective use.



Figure 2: *Adhatoda vasica* aerial parts

2.3. *Ocimum sanctum* L. (Lamiaceae)

Native to the Indian subcontinent, *ocimum* (also known as tulsi) is a sacred and medicinal plant. The labiateae family is the home of this plant. The Tulasi is a significant symbol in the Hindu religious tradition, and many Hindus worship it in the morning and evening. It is a vital component of Ayurveda, an ancient Indian system of herbal treatment. It is an aromatic sub-shrub. Because the Tulsi plant has therapeutic benefits in every section, it may be utilised to make herbal treatments to cure a wide range of ailments.

If eleven Tulsi leaves and four black pepper seeds are consumed together, malaria, periodic fever, and all other illnesses will be healed. When combined with breathing exercises and yogic asanas, tulsi offers more potent health advantages.

Tulsi is an effective treatment for issues with the digestive tract, such as poor digestion, an inability to eat, lack of appetite, constipation, gas, and acidity.

In India and a few other nations, the ethnobotany of the genus *Ocimum* has been extensively studied. The goal of the current study was to catalogue the ethnobotanical applications of *Ocimum* species in the rural Shekhawati region of India's Thar Desert.

The preservation of biological resources and their sustainable use depend on the documentation of indigenous knowledge through ethnobotanical research.

Tulsi may be a useful therapy for disorders including high cholesterol, Type 2 diabetes, ulcers, obesity, and compromised/suppressed immune systems (from conditions like cancer and AIDS). This is according to a recent study.

Because several kinds of Tulsi essential oils include eugenol and different acids have antioxidant and anti-inflammatory qualities, it is possible that the historic applications of Tulsi in Ayurveda are due to these inherent capabilities.



Figure 3: *Ocimum sanctum* whole plant

3. Major Phytoconstituents

Natural chemical substances called phytoconstituents give plants their colour, flavour, and medicinal potential. These chemicals are produced by plants as a line of defence against biotic and abiotic stressors. Antioxidant capabilities in the majority of phytoconstituents guard cells against oxidative stress. Commercial uses for phytoconstituents include medicines, enzymes, preservatives, flavours, perfumes, cosmetics, and fuels. In order to find chemical compounds with potential for use in industry and medicine, phytochemical screening is a crucial technique. Plant components (root, stem, leaf, etc.) and the methods of extraction utilised are essential for phytochemical screening and isolation.

Numerous phytochemicals fall under numerous groups, such as alkaloids, carotenoids, phenolics, flavonoids, coumarins, steroids, tannins, and others, depending on their chemical structures. Numerous phytoconstituents, particularly those from the Solanaceae, Acanthaceae, and Lamiaceae families that fall under the categories of flavonoids, phenolics, acids, and polysaccharides, have medicinal properties.



Aliphatics

The term "aliphatic" refers to organic molecules that have carbon and hydrogen bonded together in a straight chain, a branched chain, or a ring that is not aromatic. Although aliphatics can be cyclic, only aromatic compounds have an atom ring that is very stable. Members of the Solanaceae, Acanthaceae, and Lamiaceae families were found to contain a number of aliphatics, mostly fatty acids, such as palmitic acid, pinellic acid, linoleic acid, oleic acid, and steric acid. Pinellic acid has been demonstrated to have a cytotoxic impact on U87MG human glioblastoma cells in methanol extract made from *A. indicum*. Antioxidant activity may exist in palmitic acid obtained from *H. sabdariffa* flowers. While the function of other aliphatics has not yet been fully understood, evidence from other plants may point to their possible function as bioactive compounds in the many plant species as well.

Alkaloids

Alkaloids are a class of phytochemicals that contain basic nitrogen atom, although some alkaloids contain oxygen, sulfur and chlorine. Alkaloids are also a widely spread class of phytochemicals present in most of the medicinal plants. It also showed antimalarial and antimicrobial activities. Cryptolepine was also shown to be vasorelaxant in rat mesenteric artery rings. In a study by Jang et al., cytotoxic activity of quinodolinone, cryptolepinone and 11-Methoxyquinodoline from *S. acuta* was shown using a mouse mammary organ culture model.

Both human treatment and an organism's natural defence depend heavily on alkaloids. About 20% of the known secondary metabolites found in plants are alkaloids. Alkaloids in plants control growth and shield them from predators. Alkaloids are particularly well recognised for their therapeutic uses as anaesthetics, cardioprotectants, and anti-inflammatory drugs. Numerous well-known alkaloids are employed in therapeutic contexts, including nicotine, ephedrine, strychnine, quinine, and morphine. Interest in bioactive natural compounds has recently increased due to both their potential for drug discovery and a highly aggressive development in the study of traditional remedies (ethnopharmacology).

Flavonoids

Many plants, fruits, vegetables, and leaves contain phytochemical molecules called flavonoids that have potential uses in medical chemistry. Flavonoids have a variety of health advantages, such as antiviral, anticancer, antioxidant, and anti-inflammatory effects. Additionally, they have cardio-protective and neuroprotective properties. The kind of flavonoid, its (potential) method of action, and its bioavailability all affect these biological functions. These reasonably priced pharmaceutical ingredients have important biological functions, and it has been demonstrated that they are useful against several disorders. The most recent research has been on isolating them, synthesizing their analogs, and examining how they affect human health utilizing a range of methods and animal models. There have been successfully isolated thousands of flavonoids, and this number keeps rising.

Terpenes

The biggest and most diversified collection of naturally occurring substances is comprised of terpenes, sometimes referred to as terpenoids. They are divided into the categories of mono, di, tri, tetra, and sesquiterpenes based on the quantity of isoprene units they contain. They are mostly present in plants and make up the bulk of essential oils made from plants. Terpenes perform a significant and wide range of roles among the natural compounds that offer medicinal advantages to an organism.

With the general formula $(C_5H_8)_n$ and its oxygenated, hydrogenated, and dehydrogenated derivatives, terpenes are plant-derived hydrocarbons. The amount of isoprene units determines how terpenes are categorised and how they are produced from isoprene chains. There have been reports of the presence of vomifoliol, ioliolide, taraxast-1.20(30)-dien-3-one, taraxasterone, and -amyrine in *S. acuta*. In a mouse mammary organ culture model, it was discovered that the vomifoliol compound increased quinone reductase and inhibited the preneoplastic lesions caused by 7,12-dimethylbenz-[a]anthracene.



Certain terpenes were widely used in natural folk medicine. One such terpene is curcumin which holds anti-inflammatory, antioxidant, anticancer, antiseptic, antiplasmodial, astringent, digestive, diuretic, and many other properties. Curcumin has also become a recent trend in healthy foods and open doors for several medical researches. This chapter summarizes the various terpenes, their sources, medicinal properties, mechanism of action, and the recent studies that are underway for designing terpenes as a lead molecule in the modern medicine.

4. Ethnopharmacological Activities

Many academics have been interested in studying traditional cures and their potential benefits for a long time. In light of ethnopharmacological research, the development of modern treatment systems has benefited greatly from the discovery of new drugs from natural sources. Natural goods that have been used for ages to heal numerous ailments include plants, animals, and minerals. Pharmacognostical, phytochemical, and pharmacological investigations of traditional medicinal plants have recently received a lot of interest. Additionally, several preclinical and clinical investigations have examined the biological activity potential of natural medicines, revealing a variety of biological effects of a wide range of chemicals produced from plants that belong to different chemical groups.

The vast majority of the natural sources whose active ingredients are now used have an ethnomedical use. To find new sources and possible compounds for therapeutic development, numerous pharmaceutical companies have lately updated their tactics in the field of natural product research. Due to its methodology, which may be backed by experimental evidence, ethnopharmacological knowledge may be helpful for the discovery and development of innovative, safe, and economical medications. The ethnopharmacological features of herbal medicine and the process of discovering plant-based drugs will be highlighted in the current study, and significant concerns in their usage as supplemental medicine will be noted.

It is crucial to choose the plant portion utilised to make the extract in order to evaluate the ethnopharmacological activity. Additionally, the age of the plant should be taken into account while creating plant extracts since it might impact the amount of different types of chemicals, particularly alkaloids and phenolics.

Table 1: Comparison of ethnopharmacological activities of *Solanum xanthocarpum*, *Adhatoda vasica* Nees, *Ocimum sanctum* (Y—Reported; N—Not reported).

S. No.	Ethnopharmacological Activity	<i>Solanum xanthocarpum</i>	<i>Adhatoda vasica</i> Nees	<i>Ocimum sanctum</i>
1	Anti-inflammatory	Y	y	Y
2	Analgesic	Y	y	Y
3	Antioxidant	Y	y	Y
4	Antimicrobial/Antibacterial	Y	y	Y
5	Anti convulsant /Neuroprotective	Y	y	Y
6	Antiulcer	Y	N	Y
7	Physical stress	Y	N	Y
8	Diabetes mellitus	Y	Y	Y
9	Antipyretic	Y	Y	Y
10	Antiviral	Y	Y	Y
11	Anti-hypertensive & Vasorelaxant	Y	Y	Y

4. Toxicity Studies

In a research on acute toxicity, rats and mice were given an aqueous extract of *S. xanthocarpum* fruits at a dosage of 2000 mg/kg p.o. for up to 4 hours showed no behavioural abnormalities. Additionally, no mortality was noted



through the conclusion of 48 hours. At a dosage of 2000 mg/kg, p.o., the ethanolic extract (50%) of fruits did not cause death in swiss albino mice.

Only 2 individuals with asthma/rhinitis demonstrated a significant positive skin test response in a pilot study of airborne *A. vasica* pollen grains and a clinical pollen allergy survey done at Kolhapur during monsoon season.

On rats and monkeys, a research on chronic toxicity was carried out. Vasicine hydrochloride, isolated from the plant, did not exhibit any harmful effects when given orally in low (2.5 & 5 mg/kg), medium (5 or 10 mg/kg), and high (10 or 20 mg/kg) dosages for six months.

The plant's whole extract, dissolved in water, was determined to be safe when given orally to rats every day for 90 days at dosages of 2.0, 4.0, or 8.0 ml/kg body weight.

Mice were given graduated dosages (3500-6300 mg/kg, BW) of aqueous and alcoholic extracts of *O. sanctum* leaves intraperitoneally, and mortality was tracked for 72 hours. At dosages up to 5 g/kg, BW, the administration of the aqueous extract did not result in any acute toxic symptoms, and the alcoholic extract was well tolerated (80% survival) up to a dose of 4 g/kg, BW. Acute LD₅₀ values were discovered to be 6200 mg/kg BW and 4600 mg/kg BW for aqueous and alcoholic extracts, respectively.

Through intra-peritoneal injection to experimental rats, the toxicity of fixed oil (seed oil) of *O. sanctum* has also been investigated. Fixed oil was administered in a graduated way up to 55 ml/kg, BW, in a research on acute toxicity. At 30 ml/kg BW, there was no death, at 55 ml/kg BW, there was 100% mortality. Fixed oil's LD₅₀ was discovered to be 42.5 ml/kg, BW.

5. Conclusions

Ayurvedic medicine uses plant products, either as a single medicament or in combination with additional substances (polyherbal formulation), which are said to be less toxic and side effect-free than synthetic medications.

The hunt for novel medications continues despite significant advancements in the treatment of pain, diabetes, and microbial infections using external synthetic or herbal formulations since the current synthetic or herbal medications have a number of drawbacks. Polyherbal compositions show potential in this situation for managing the aforementioned issues. Such plants as *S. xanthocarpum*, *A. vasica*, and *O. sanctum* have a long history of usage as analgesics, antidiabetics, and antimicrobials.

Their conventional claims have received some confirmation from a small number of preclinical and clinical trials. The goal of the current studies was to create an optimised polyherbal formulation of these herbs that have high patient compliance. After employing the Soxhlet equipment to beautify using n-hexane solvent, the methanol extract was produced. Lipids were present in the n-hexane extract, whereas alkaloids, steroids, triterpenoids, flavonoids, tannins, saponins, proteins, and carbohydrates were present in the methanol extract.

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