

# PRACTICE AND RE-EMERGENCE OF HERBAL MEDICINE



Editors:  
**Raja Chakraborty**  
**Saikat Sen**

**Bentham Books**

# **Natural Medicine**

***(Volume 1)***

## ***Practice and Re-Emergence of Herbal Medicine***

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## PREFACE

The Indian codified system of medicines like Siddha, Unani, Amchi and Ayurveda has very excellent evidence of effectiveness. Plants are the main component of these systems of medicine, which include more than 1200 plant species in Ayurveda, 900 plant species in Siddha, and 700 plant species in Unani. Folk medicines are also extremely accepted in India for regular health care management in remote and rural areas. In this system of medicine, a maximum number of more than 8000 plant species and more than 25000 effective formulations are practiced by folk medicinal practitioners. Traditional medicines make numerous medical claims for the treatment of many acute and chronic diseases and symptoms, the prevention of disease, and the improvement of quality of life. Herbal medicines also contain different chemical constituents that could act singly or synergistically. The isolation and identification of phytochemicals can act as lead for the discovery of bioactive molecules. Advanced scientific methods like reverse pharmacology, chromatography and spectral studies made the discovery of new drugs from the plant source more efficient. The demand for herbal medicines, herbal health products, herbal pharmaceuticals, nutraceuticals, food supplements, herbal cosmetics, *etc.*, is increasing globally due to the growing recognition of these products as mainly non-toxic, having in the mainly fewer side effects, better compatibility with physiological flora, and availability at affordable prices. In the last century, medical science has made incredible advances all over the globe. In spite of global reorganization and a very sound history of traditional uses, the promotion of herbal medicine faces a number of challenges around the globe, mainly in developed nations. Regulation and safety is the high concern for the promotion of herbal medicine. Quality issues and quality control, pharmacovigilance, scientific investigation and validation, IPR, and biopiracy are some key issues that restrain the advancement of herbal medicine around the globe. In the twenty-first century, demand for medicinal plants, herbal medicines, pharmaceuticals, food supplements, health products, cosmetics, *etc.*, is growing, which demands more research, enhanced regulation, and addressing quality control issues. Volume 1 of this series of the book entitled “Natural Medicine: Practice and Re-emergence of Herbal Medicine” is devoted to the current research in Plant-based medicine in Ayurveda, Siddha, Folk medicinal systems, and any other traditional system of medicine, Quality control & Validation of herbal medicine, IPR issue & Herbal medicine. We are confident that the volume will have a great effect, attract an audience worldwide, and be a repository of knowledge on the topic.

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## CHAPTER 1

## Exploring the Traditional System of Medicine With Special Emphasis on the Indigenous Practice of Herbal Remedy by the Tribals of North-East India

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**Abstract:** The tribal people of India consider North-East India to be a hotspot. It contains eight states: Arunachal Pradesh, Assam, Manipur, Mizoram, Meghalaya, Nagaland, Tripura and Sikkim, and it borders international boundaries with Bhutan, Tibet, China, Burma and Bangladesh. The Indo-Burma biodiversity hotspot, which is home to a broad spectrum of unusual flora, fauna and microorganisms, is located in the Northeast Region. The region has the evergreen forest of the Brahmaputra River valley, wide leaf forest, dense bamboo and pine forest and the world's wettest location (Cherrapunji and Mawsynram), all of which help to maintain the region's unique biodiversity. North East region is the inhabitant of more than 145 significant tribal communities with the most dominating primitive societies, including the Abor, Mishng, Rabha, Khasi, Kuki, Naga, Meitei, Apatani, etc. Most of these communities are culturally and linguistically diverse. The NER's tribal population is literate compared to other parts of the country, and it's worth noting that the literacy rates in Mizoram, Meghalaya, Nagaland, Sikkim and Manipur are all higher than the national average. Despite their high literacy rate, India's North-Eastern states continue to have poor transportation, power and medical services. The healthcare system is in bad shape, with only a few hospitals and nursing homes. As a result, the people residing in this area rely exclusively on a traditional system of medicines made by traditional healers from plants, animals and mineral resources. It was stated that medicinal herbs are prepared using traditional methods, such as maceration, decoction, and infusion, either alone or in combination with other plants. The key species of medicinal plants often employed by the traditional healers of the region are *Acorus calamus*, *Aegle marmelos*, *Asparagus racemosus*, *Averrhoa carambola*, *Bryophyllum calycinum*, *Costus speciosus*, *Euphorbia neriifolia*, *Justicia adhatoda*, *Melia azadarachta*, *Plumeria acutifolia*, *Sida cordifolia*, *Sida rhombifolia* and *Swertia chirata*. This extensive work will aid the researcher in locating previously unknown medicinal plants in order to build a new therapeutic method for isolating new chemical entities that are safe, pharmacologically active, and cost-effective.

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**Keywords:** Medicinal plant, North-East India, Traditional medicine, Traditional healers.

## INTRODUCTION

Plants have been used as medicines and in making food in many cuisines since ancient times [1]. The history of healthcare in India may be traced back to 5000 B.C., as evidenced by ancient texts, such as the '*Rig-Veda*' and '*Atharva-Veda*' [2]. Later literature such as the '*Charak Samhita*' and '*Sushruta Samhita*' about 10<sup>th</sup> century B.C. and traditional medical systems such as *Ayurveda*, *Siddha*, and *Unani* emphasized the usage of plant species to treat various ailments due to an extensive supply of bio-diversity of herbs [3, 4]. Plants were the primary therapeutic agents utilized by humans until the mid-nineteenth century, and they continue to play a vital part in pharmaceutical formulations [5]. Many rural communities in underdeveloped countries view traditional medicinal plant-based therapy as a substantial healthcare contribution due to their strong belief in allopathic drugs and restricted access to them. Around 80% of people in undeveloped countries rely on medication for their primary healthcare needs because of its low pricing, effectiveness, and frequently restricted supply of modern medicine, as well as cultural and religious preferences [6]. Traditional medicinal plant research has become more critical in developing healthcare and conservation initiatives in many regions of the world [7]. Bioactive compounds with pharmacological interest are being sourced from traditional medicine systems [8]. Traditional medicine is practised by numerous ethnic groups in India, each having its distinct cultural origins. Eighty percent of Indians use herbal-based medicines derived from wild and cultivated sources that are non-allopathic (*Ayurveda*, *Siddha*, *Unani*, and *Homeopathy*) [9]. India is also a nation of many groups, each with its own set of beliefs, customs, religions, languages, and dialects. As a result, several folk treatments were used in this area [10].

## GEOGRAPHICAL LOCATION AND BIODIVERSITY OF NORTH EAST INDIA (NEI)

Biodiversity refers to the variety and variations among living species from various environments, such as terrestrial, marine, and other aquatic ecosystems, as well as the ecological complexes in which they exist. North-East India is a part of both the Himalayas and Indo-Burma biodiversity hotspots [11]. The region is rich in biodiversity with maximum endemic species. It is located between latitudes 22°N and 29°5'N, and longitudes 88°E and 97°30'E, and shares an international boundary with Bangladesh, Bhutan, China, and Myanmar, comprising eight states such as Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura. It accommodates different living forms due to its huge

diversity in soil, slope, elevations and ecological circumstances; plant biodiversity is largely the basis of human life on Earth, and agriculture production systems exist among farming communities [12, 13]. Northeast India is physically located in one of the world's most biodiverse areas. The region has gone through multiple priority-setting procedures on the initiative of national and international conservation bodies during the last three decades. The region has a climatic situation between tropical to alpine environment ranges; the soil is rich in organic matter, having a pH between 4.5 to 5.0. India is one of the world's seventeen major biodiversity hotspots, with many plant species reported. The region covers around 8% of the country's overall land area and is inhabited by 225 indigenous communities [14]. Although the region only accounts for around 8% of the country's overall land area, it contains 25% of its entire forest area and supports roughly 30% of its total forest growth stock. Forest cover covers over 64% of Northeast India's entire geographical area, with the government controlling 35% and District Councils, Village Communities, and private ownership controlling the remaining 65%. There are roughly 7500 angiosperm species in the area. Northeast India is home to more than 200 of India's 315 angiosperm families, accounting for nearly half of the country's total number of plant species. It is interesting to note that one-third of the flora of Northeast India is endemic to this region [15].

## **ETHNIC TRIBAL'S OF NORTH EAST INDIA AND THEIR INDIGENOUS PRACTICE**

### **Arunachal Pradesh**

Arunachal Pradesh (AP) is the biggest state in India's North East region, and it is well known for its unique indigenous population. With a size of 83,743 km<sup>2</sup>, the state shares international borders with Bhutan, Myanmar, and China. According to the 2011 census, the state's total population is 1,382,611, with a population density of 17 persons per km<sup>2</sup> (Census 2011). The state is home to 26 main tribes and 110 sub-tribes, as well as lesser tribes, each with its own culture and traditions. It's fascinating to see that 110 of NE's 219 tribal communities are still active in the state, accounting for about half of all tribal communities [16]. The major tribes of the state include Adi, Apatani, Bangni, Boker, Bori, Digaru, Mishmi, Hill Mishmi, Hrusho (Aka), Idu Mishmi, Khamba, Khamti, Khowa, Memba, Miri, Miju, Monpa, Nyishing, Nocte, Pallibo, Poma, Sherdukpen, Singpho, Sulung, Tagin, Tongsha, and Wangcho [17, 18]. Each of these villages has its own way of life, culture, beliefs, and linguistic system. Several mountain ranges have covered 85 percent of the entire area [19]. Tropical and sub-tropical forests encompass 62 percent of the total land area and include over 500 different

## CHAPTER 2

## Traditional Herbal Medicines: A Prospective Panacea for SARS-CoV-2

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**Abstract:** The pandemic has trembled the world with the massive outbreak, leaving the scientific fraternity in shambles. The SARS-CoV-2 strain took a heavy toll and led to the death of millions of people. In late 2020, various mutated strains of the virus surged the disease across the world. For the same, diverse methods were used around the globe in search of precise medication against the pandemic. Despite vaccination for viral disease prevention, the virus has spread without restraint, making the need for strong antiviral drugs- a need of the hour. Several techniques were used for the fabrication of a strong antiviral drug in different modes of remedies. Many countries utilized their conventional therapeutic knowledge against the virus, which comprises the use of indigenous phytochemicals with varied biological activities. The present review includes the virology, epidemiology, and different therapeutic procedures practiced globally to combat the viral disease and highlights different indigenous potent plants with biological activities, such as antiviral, antipyretic, immunomodulatory and antimicrobial. These plants are efficacious and can be explored further as prospective remedies for many other maladies affecting the world.

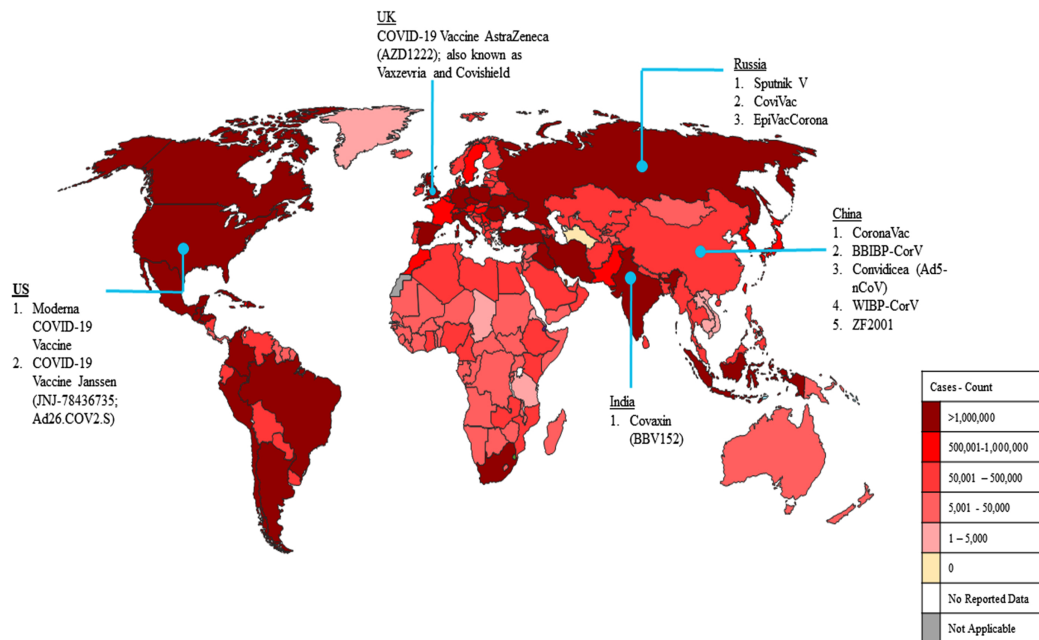
**Keywords:** B.1.617, COVID-19, Coronavirus, Herbal Medicines, Indigenous Curatives, Lopinavir, Remdesivir, SARS-CoV-2, 2-deoxy-D-glucose, Traditional Medicines.

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## INTRODUCTION

Severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), earlier known as novel coronavirus or COVID-19, emanated from Wuhan, Hubei province, central China and has propagated to 220 countries to date. It has severely affected the world and was proclaimed a global pandemic by World Health Organization (WHO) on 11<sup>th</sup> March, 2020. The major and most populous countries like USA, India, Brazil, France, Turkey, Russia and UK are gravely suffering from the rage of the virus. According to the reports by WHO, more than 28 crore people got affected by the virus, with more than 54 hundred thousand cases of death (Fig. 1) [1].



**Fig. (1).** Depicts the extent of the spread of SARS-CoV-2 all around the world.

SARS-CoV-2 provenanced from the Coronaviridae family which has four genera- alphacoronavirus ( $\alpha$ -CoV), betacoronavirus ( $\beta$ -CoV), gammacoronavirus ( $\gamma$ -CoV) and deltacoronavirus ( $\delta$ -CoV). Alpha and betacoronavirus are known to affect mammals. The recent outbreaks of 2002, 2012 and 2019 were due to the  $\beta$ -CoV [2]. The SARS-CoV 2002 outbreak had a 9.7% of case fatality rate and a total of 8098 reported cases with 774 deaths. In contrast, the Middle East respiratory syndrome coronavirus (MERS-CoV) arose in 2012 with a high mortality rate of

34% and has 2494 reported cases and 858 deaths in 27 countries [3]. The prodrome of the virus causes symptoms like fever, dyspnea, dry cough, fatigue and myalgia, with less common symptoms being vomiting, nasal congestion, runny nose, headache, diarrhoea and sore throat. The path of treatment followed by the medical fraternity is bed rest, supportive treatment, along with a large intake of nutritious supplements to enhance the immunity of the body to combat the infection [2]. In late 2020, a new variant of SARS-CoV-2 emerged in UK, making the world astounded by the improbable rise in the cases along with a surge in death rate as they quickly spread across the world later on in early 2021; many new variants also emerged from countries like Brazil, India, and many other countries which further worsened the condition. At the same time, as a new hope many vaccines have emerged in different parts of world to overcome the fast-mutating ghastly pestilence.

Although vaccines have emerged, individuals infected with a virus cannot be vaccinated right away, so the current treatment regime includes Allopathic antiviral drugs such as remdesivir, lopinavir, and chloroquine (CQ) for the treatment of coronavirus infection. These drugs contain antiviral abilities and are found to be effective against SARS-CoV-2 [4]. In addition to these medicines, various techniques are also used for their treatments which have their own limitation. Although these medicines are used against SARS-CoV-2, due to their synthetic origin, they work on the targeted pathogen and do not work on the upliftment of the immunity of patients during the course of treatment, which becomes extremely important as the body becomes weak. Interestingly, the traditional mode of treatment boosts immunity along with eliminating the disease-causing pathogen. The classical Indian system of medical treatment called ayurveda is based on ancient writings that rely on indigenous and folk medical approaches to physical and mental health. This folk culture of treatment is based on the union of herbs, a healthy diet, exercise and lifestyle. Among various indigenous herbs, *Glycyrrhiza glabra* (mulethi), *Tinospora cordifolia* (giloy), *Strobilanthes cusia* (assam indigo), *Strobilanthes callosus* (maruadana), *Clerodendrum inerme gaertn* (batraj), *Eucalyptus globulus*, *Justica adhatoda*, *Camellia sinensis* are some of the major plants potent against SARS-CoV-2 [4 - 6]. There are various decoctions prepared by the combination of traditional flora. These decoctions work as immune modulators and restrain the entry and action of a pathogen in the body alongside the natural disinfectants which help in the purification of the environment; this makes the indigenous mode of treatment, an unerring cure for this pandemic. The present review elaborates on the virology and epidemiology followed by the current therapies used as curative accompanied by an indigenous form of treatment against the SARS-CoV-2 infection. The aboriginal curative comprises antiviral, antipyretic, immunomodulator, antimicrobial and disinfectant.

## CHAPTER 3

## Ethnobotany, Ethnomedicine, Chemistry and Pharmacology of *Clematis* Species Used in Australia, China and India

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**Abstract:** Plants are the biggest bioresources for newer drugs or therapeutical agents. Genus, *Clematis* of family Ranunculaceae is one such bioresource whose species have been used traditionally for the treatment of snake bites, malaria, dysentery, rheumatism, inflammation, urinary and skin disorders, blisters, wound, ulcers, colds and headaches in Australia, China, India and other countries. Modern research revealed that *Clematis* species possess pharmacological properties of anti-inflammatory, anti-rheumatoid arthritis, anti-diabetic, anti-apoptosis, anticancer, antioxidation, antimicrobial, hepatoprotection, diuretic and hypotensive. Genus *Clematis* has approximately 355 species that are spread across the globe. Chemical constituents isolated from different species of this genus have been categorized under some of the biologically potent phytochemical classes, such as alkaloids, triterpenoid saponins, lignans, flavonoids and phytosterols, which may account for the pharmacological action. The present chapter will focus on common species used in the Australian, Chinese and Indian traditional systems of medicine. Their ethnobotany, ethnomedicine, chemical constituents and pharmacological activities are critically reviewed.

**Keywords:** Alkaloids, *Clematis* Species, Chemical Constituents, Ethnobotany, Hederagenin, Lignans, Oleanolic Acid Glycosides, Pharmacological Activity, Ranunculaceae, Triterpenoid Saponins.

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## INTRODUCTION

Genus *Clematis* belongs to the family *Ranunculaceae* and has around 355 species in the World [1]. Most of the species are of Chinese or Japanese origin. Various hybrids or varieties of *Clematis* species have been developed, which are popular among gardeners across the globe for their aesthetical values in addition to their ethnomedicinal use. The National Centre for Biotechnology Information (NCBI) Taxonomy Browser lists 176 species, including 19 unclassified *Clematis*, but excluding 18 cultivars [2]. For the NCBI taxonomy, a recent update on curation, resources and tools was published [3].

The genus *Clematis* derives from the ancient Greek word *clématis*, meaning “a climbing plant”. The genus is mainly composed of woody, but fragile climbing vines, with some being shrubby and some perennial herbs. All *Clematis* species have one thing in common – beautiful flowers – thus have been popularly cultivated as ornamental plants, and hundreds of cultivars have been created [4]. Besides their aesthetical or ornamental value, *Clematis* species have been used in traditional medicine systems worldwide for the treatment of various conditions. In the European, Australian and Asian sub-continent, *Clematis* species have been used for the treatment of snake bites, malaria, dysentery, rheumatism, inflammation, and urinary and skin disorders [5]. Paste or poultice of aerial parts of various *Clematis* species has also been used for the treatment of blisters, wounds and ulcers [5, 6].

*Clematis* species possess chemical constituents, including the known classes of saponins, lignans, flavonoids, alkaloids and steroids, which may account for various pharmacological activities, such as anti-inflammatory, anti-rheumatic, anti-diabetic anti-apoptosis, anticancer, antioxidant, antimicrobial, hepatoprotective, diuretic and hypotensive. The present chapter will focus on common species used in the Australian, Chinese and Indian traditional systems of medicine (Table 1). Their ethnobotany, ethnomedicine, chemical constituents and pharmacological activities are critically reviewed.

## ETHNOBOTANY AND ETHNOMEDICINE

### The Australian Clematis

The Australian *Clematis* species are more robust and drought tolerant than their highly bred exotic relatives. They're also evergreen, with more demure flowers in white, cream or greenish colour. The most widespread species is *Clematis microphylla* (Small-leaved Clematis), which can be found everywhere except the Northern Territory. But don't despair if you live up north because *Clematis pickeringii* is an excellent vigorous climber for tropical gardens. Of approximately



355 species of *Clematis* in the world, only six or seven are endemic to Australia. All *Clematis* produce star-shaped female and male flowers on different plants. After flowering, the fruit develops from the female flowers into an achene (small dry fruit) with a long tail of silky plumes [7].

**Table 1. Common species used in the Australian, Chinese and Indian traditional systems of medicines. Note that the bold-typed species are listed in the NCBI's Taxonomy Browser [2].**

Appearing	Australian <i>Clematis</i>	Chinese <i>Clematis</i>	Indian <i>Clematis</i>
In Ethnobotany and ethnomedicine section	<i>C. microphylla</i> <i>C. glycinoides</i> <i>C. pickeringii</i> <i>C. aristata</i> <i>C. fawcettii</i> <i>C. gentianoides</i> <i>C. pubescens</i>	<i>C. chinensis</i> <i>C. terniflora</i> <i>C. mandshurica</i> <i>C. hexapetala</i> <i>C. armandii</i> <i>C. montana</i> <i>C. serrifolia</i> <i>C. fusca</i>	<i>C. wighatiana</i> <i>C. acuminata</i> <i>C. graveolens</i> <i>C. gouriana</i> <i>C. heynei</i> <i>C. buehneriana</i> <i>C. grata</i>
In Table 2 hederagenin type triterpenoid saponins	-	<i>C. mandshurica</i> <i>C. chinensis</i> <i>C. terniflora</i> <i>C. stans</i> <i>C. tangutica</i> <i>C. ganpiniana</i> <i>C. tibetana</i>	-
In Table 4 oleanic type triterpenoid saponins	-	<i>C. chinensis</i> <i>C. mandshurica</i> <i>C. stans</i> <i>C. terniflora</i> <i>C. montana</i>	-
In Table 6 Various lignans	-	<i>C. stans</i> <i>C. chinensis</i> <i>C. armandii</i> <i>C. manshurica</i> <i>C. hexapetala</i> <i>C. parviloba</i> <i>C. tangutica</i> <i>C. tibetana</i>	-
In Table 10 various flavonoids	-	<i>C. hexapetala</i> <i>C. manshurica</i> <i>C. stans</i> <i>C. terniflora</i>	-

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**CHAPTER 4**

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## **Virility to Fertility: An Evidence-Based Study on Traditional Herbal Aphrodisiacs**

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**Abstract:** More than 60% of people globally rely on herbal medicines as a source of healthcare. Traditional herbal preparations can be traced back to ancient literature, folk knowledge, and ethnic practices. Traditional herbal products are preferred over synthetic drugs since these are considered more accessible, affordable, culturally acceptable, non-toxic, and sustainable. Globally 15% of couples are affected with infertility, 20-30% of which are attributed to the male factor. Fertility-enhancing drugs and hormonal methods such as testosterone replacement therapy (TRT) increase testosterone levels in males but may result in other side effects. Assisted reproductive technology (ART) remains expensive medicare throughout the world despite its widespread use, and its success rate also varies with the age of the partner, apart from other complexities. Aphrodisiacs (Greek - Aphrodisiakos: sexual) are agents that provoke sexual desire and increase performance. Aphrodisiac herbs have been in use for thousands of years by various civilizations worldwide involving the traditional healers and have been mentioned in different ancient literatures, including Ayurveda, Unani, Siddha, and Chinese Pharmacopoeia. Apart from increasing sexual desire and performance, these herbs have perceived roles in enhancing fertility. Physiologically, herbal aphrodisiacs induce virility and reproductive wellbeing of men by modulating

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gonadal as well as neuro-endocrine systems through the interplay of hormones and biogenic substances. Unfortunately, sometimes the marketed herbal aphrodisiacs are adulterated with synthetic compounds, which necessitates further studies and validation of such preparations for widespread clinical use in the workup algorithm of patients, particularly in cases of idiopathic male infertility and erectile dysfunction. Confirmatory laboratory studies, human clinical trials and case studies will be of paramount use in validating the role of such traditional herbal medicines as aphrodisiacs in restoring virility and fertility of men who may be in need.

**Keywords:** Erectile dysfunction, Herbal aphrodisiac, Male infertility, Reproductive biomedicine, Traditional medicine.

## INTRODUCTION

As human civilization progresses towards scientific developments, much of health concerns are being addressed. Reproductive disorders, especially virility in males and infertility in both sexes, raise the alarm in today's societies. There is an increasing trend of decline in the fertility rate in humans. A gradual reduction in human sperm count from 113 M/ml in 1940 to 66 M/ml in 1990 has been reported [1]. In 1974 too, the incidence of declining sperm quality was reported [2], in comparison to the reference limits provided by Mcleod and Gold [3]. Another study encompassing 20 years has recorded a deterioration in sperm count at 1.5% per year [4]. Globally, around 15% of couples are affected with infertility, of which 20-30% are attributed to male factors [5]. With changing lifestyles and environmental disturbances [6], there is a steady decline in serum androgen levels, which affect fertility and virility in men [7], which may result in sexual dysfunction. Sexual dysfunction is a physiological, psychological, and social symptom that occurs in 10-52% of males and 25-63% of females. Apart from the above-mentioned factors, stress plays a significant role in deteriorating sexual health. Stress is one of the major factors which hampers most of the normal physiology, including those of the reproductive system rendering sexual disorders, hypogonadism [8], impotence, ejaculatory and erectile dysfunction (ED) [9, 10]. Prolonged stress results in an increased level of cortisol in the serum [11], which affects spermatogenesis by generating reactive oxygen species (ROS) [12 - 14]. ED is unable to achieve or maintain penile erection sufficient to aid satisfactory sexual performance [15]. It is one of the most common sexual dysfunctions experienced by men, partly due to andropause and to some extent due to hormonal or psychological disturbances [16, 17], which leads to the loss of meaning and value of a man's life as well as a feeling of psychological frustration, social conflict, a family disagreement which ultimately affect couple intimacy and sexual harmony [18]. Increasing age, lower levels of androgens, free radicals, disorders like diabetes, atherosclerosis, and unhealthy lifestyle are some factors responsible for infertility [19 - 21].

Since ancient times humans across diverse cultures have taken a keen interest in agents that enhance sexual ability [22, 23], pleasure and libido [24, 25], and treat sexual dysfunctions and impotence [24, 25]. The word 'aphrodisiac' is derived from Aphrodite, the Greek goddess of love and beauty (Greek-Aphrodisiakos: sexual). An aphrodisiac is an agent, food or drug that provokes sexual desire, maintains libido, and increases sexual performance [17, 26]. Although aphrodisiacs can be of plant, animal, or synthetic origin, those derived from plants are preferred due to lesser side effects [27]. Most of the aphrodisiac formulations available commercially contain Asian herbs, of which Indian and Chinese herbs are the most prominent. The use of herbal aphrodisiacs can be traced back to 1700 B.C.E. in Egyptian writings and 300 B.C.E. in traditional Chinese medication, whereas the use of plant preparations by ancient Babylonians to increase sex drive dates back to 6000 years [28]. Indian systems of medicine such as Ayurveda (Ayu meaning life and Veda meaning science in Sanskrit), Naturopathy, Siddha and Unani have a great deal of information regarding the use of such herbs. In Ayurveda, herbs having aphrodisiac properties are grouped into a class of drugs known as Vaishya or Vajikarana [29]. Vajikarana Rasayana, or aphrodisiacs, modulate the neuro-endocrine system by acting upon the hypothalamus and limbic systems. Aphrodisiacs have been claimed to have anti-stress and adaptogenic properties (which assist in combating stress, and disease and improving physical strength), which help alleviate the anxiety associated with sexual desire and performance [30]. According to the Unani system of medicine, many herbal formulations are used to enhance fertility [31], and as aphrodisiacs [32]. According to the Unani system of medicine, diabetes-induced ED can also be treated using herbal products [33]. As per Siddha medicinal system, some Indian flowers have potential aphrodisiac qualities [34], and their potent use as aphrodisiacs also found mention in Ayurvedic texts.

In general, the use of herbal medications has been on the rise over the past few decades, with approximately 80% of the world population relying on traditional plant-based products [35, 36]. This may be attributed partly to the belief that herbal products have fewer side effects and are more effective than synthetic drugs [37, 38]. Herbal medicines are considered more readily available, affordable, accessible, culturally acceptable, and sustainable than synthetic ones [39]. According to the World Health Organization (WHO), herbal medicines include herbs, herbal preparations, materials, and all finished herbal products that contain plants, other plant materials, or combinations, as active ingredients [40]. But many herbal materials documented as medicinal have yet to be validated scientifically. This review aims to identify the commonly used herbal aphrodisiacs used for enhancing sexual performance and managing various sexual disorders, including ED and male infertility, with a focus on the scientific validity of such traditional aphrodisiacs. Their modes of action are also discussed.

## CHAPTER 5

## Evidence-Based Potential Leads for Antimalarial Drug Development: An Insight into Classical Ayurveda Treatment

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**Abstract:** Ayurveda is not merely a branch of medicine; this is a 'knowledge system' that deals with the unremitting association between the living and its contiguous environment to maintain the state of equilibrium and health of human beings as well as the environment. Historical records suggest Malaria has infected humans since the early commencement of mankind. Human Malaria is caused by single-cell protozoan parasites present in the Plasmodium genus, which is transmitted through the bite of female mosquitoes, Anopheles. The World malaria report (WMR) 2019 estimates that globally, there were estimated 228 million cases of Malaria in 89 countries. According to the WMR 2019, India represents 3% of the global malaria burden. In Ayurveda, Malaria is well thought-out under the portrayal of *Vishama Jvara* (irregular), which means 'irregular' in every aspect, including- its origin, symptoms, and periodicity. This is generally involved in the *rasa dhatu* (nourishment tissues), and irregularly attacks the body to manifest the symptoms. Hence, even if the fever subsides, the patient feels fatigued, heavy and exhausted. These signs and symptoms of *Vishama Jvara* are classically reverberating with conventional malarial fever, wherein the fever subsides and reappears at fixed intervals. This feature of the fever is described in Ayurveda as *Muktaanubandhitvam* (reappearing at regular intervals). To date, no effective vaccines are commercially available to prevent this endemic crisis. Research-based traditional knowledge system has significantly contributed by yielding two potent antimalarial drugs: alkaloid quinine derived from the bark of *Trinayanani* (Cinchona tree) and artemisinin derived from the plant *Damanaka* (*Artemisia annua* L.). In the midst of increasing problems of drug resistance along with difficulties in affording and acces-

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sing effective antimalarial drugs in underprivileged areas, therefore traditional medicines like Ayurveda have become an important and sustainable source of treatment of Malaria. The present review focused on evidence-based potential leads in Ayurveda for the treatment as well as drug development for Malaria. The information from different classical texts along with research papers, including books, journals and documents of different universities and institutes, has been collected and analyzed for the evidence-based lead on different single and multidrug plant-based formulations used for Malaria.

**Keywords:** Malaria, Vector born infectious disease, Vishama Jvara, Traditional medicine.

## INTRODUCTION

Malaria is a vector-born infectious disease, endemic in the tropical and subtropical climates of the world. The World Malaria Report (WMR) 2019 estimates that globally, there were estimated 228 million cases of Malaria in 89 countries. According to the WMR 2019, India represents 3% of the global malaria burden [1]. Early diagnosis and comprehensive treatment of Malaria is the only way to tumble malaria transmission as well as diminish disease and deaths. In Ayurveda, Malaria is well thought-out under the rendering of *Vishama Jvara*. The pattern of irregular onset, inconsistent symptoms, manifestation in irregular time and anecdotal duration as explained by Vagbhata in the context of *Vishama Jvara* (irregular or intermittent fever), the impairment of Dhatus (tissue elements of the body) as mentioned by Acharya Charaka or the *Agantuja Nidana* (external etiological factors) by Acharya Sushruta are all pointing to the direction of *Vishama Jvara* (irregular or intermittent fever) resemblance to Malaria [2 - 4]. To date, no effective vaccines are commercially available for the prevention of Malaria. The research-based Traditional knowledge system has significantly contributed to combatting this endemic crisis [5]. In the midst of increasing problems of drug resistance along with difficulties in affording and accessing effective antimalarial drugs in underprivileged areas, traditional medicines like Ayurveda have become an important and sustainable source of treatment of Malaria. The present review focused on evidence-based potential leads in Ayurveda for the treatment as well as drug development for Malaria. The information from different classical texts along with research papers, including books, journals and documents of different universities and institutes, has been collected and analyzed for the evidence-based lead on different single and multidrug plant-based formulations used for Malaria.

## RUDIMENTS OF AYURVEDA

“Ayurveda” the word comes from the Sanskrit terms Ayur (life) and Veda (knowledge), is the ancient medical science prevalent for thousands of years in the Indian subcontinent. Ayurveda believes that the entire universe is composed of five elements: *Vayu* (Air), *Jala* (Water), *Aakash* (Space or ether), *Prithvi* (Earth) and *Teja* (Fire). These five elements (referred to as *Pancha Mahabhoota* in Ayurveda) are believed to form the *Tridosha* i.e., the three basic humors of the human body in varying combinations. The three humors; *Vata dosha*, *Pitta dosha* and *Kapha dosha*, are collectively called “*Tridoshas*” and control the body's basic physiological functions along with five *sub-doshas* for each of the principal *doshas*. According to Ayurveda, the human body consists of *Saptadhatu*s (seven tissues) *Rasa* (tissue fluids), *Meda* (fat and connective tissue), *Rakta* (blood), *Asthi* (bones), *Majja* (marrow), *Mamsa* (muscle), and *Shukra* (semen) (Fig. 1) and three *Malas* (waste products) of the body, viz. *Purisha* (faeces), *Mutra* (urine) and *Sweda* (sweat). These seven tissues work in coordination with each for the proper physiological functioning of the human body. The *Rakta Dhatu* resembles the blood and regulates the circulation of blood cells and provision of blood components to the body. The *Mamsa Dhatu* (Muscle tissue) provides support in the form of skeletal muscles for the *Meda Dhatu* (adipose fat). The *Asthi Dhatu* comprises the bones of the body, and the *Majja Dhatu* is made up of the bone marrow and fluids required for the bones' oleation and functioning. The *Shukra Dhatu* is responsible for the functions of the body's reproductive organs. As per Ayurveda principles, the equilibrium state of all these *Dosha*, *Dhatu* and *Mala* are essential for a sustainable healthy life; on the journal hand, misbalance of these factors is responsible for any disease conditions. The treatment principles of Ayurveda for kind of pathological conditions in the body to balance these *Dosha*, *Dhatu* and *Mala* by medicines and diet based on *Desha* (*Bhumi desha*-Geographical locations) *Atura desh*-Individual constitution/Patients conditions) and *Kala* (Seasonal variation and Stage of disease conditions).

## CHAPTER 6

## Insights of Nutravigilance in Ayurveda Classics

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**Abstract:** *Ahara*, i.e., diet, possesses a very significant place in Ayurveda which is evident from its inclusion among *Trayoupastambha* (three main pillars of life). According to classical literature, Ayurveda places significant importance on food and categorizes it in various ways based on factors such as an individual's constitution, properties of the food, therapeutic benefits, and more. Food has been considered as medicine, and according to *pathya Kalpana*, dietary restrictions along with disease-specific recipes have been vividly mentioned. Apt, optimal and dexterous use of them facilitates the human body to sustain its integrity, being enriched with *bala* (strength), *varna* (complexion), and *upachaya* (growth of nourishment) till longevity. Considering the essentiality of food, the treatise has also focussed on the need for vigilance in the case of diet. Thus, this chapter is an effort to discuss the insights into nutra-vigilance from Ayurveda Classics.

**Keywords:** *Ayurveda, Ahara, Agrya, Agni, Diet, Food Incompatibility, Dietary restrictions, Pathya, Prakriti, Viruddhaahara.*

### INTRODUCTION

Ayurveda is known as the science of life wherein food has been regarded as the best medicine to maintain optimum health [1]. *Ahara* (diet) has been considered to be one of three pillars of life in Ayurveda classics which suggests the immense significance bestowed on food [2]. Apt, optimal and dexterous use of them facilitates the human body to sustain its integrity, being enriched with *bala* (strength), *varna* (complexion) and *upachaya* (growth of nourishment), till longevity. The categorization of food is based on its appropriateness to the body

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and mental constitution, *i.e.*, *Prakriti*, which is ultimately dependent on the *panchamahabhuta* (five elements) and the *tridosha* (*Vata Pitta* and *Kapha*) theories. Ayurveda has explicated the food and lifestyle as per the individual constitution, including the factors which influence doshas [3]. Ayurveda classics exhibit detailed descriptions of food and beverage, food categories based on their taste, properties and therapeutic qualities [4]. A unique precept of food incompatibilities based on numerous factors, *viz.* processing, dose, time, place, *etc.*, is yet another portrayal of vigilance in Ayurveda [5]. Cautious declarations regarding prescriptions of consumption, food qualities and intake based on the *Agni* (metabolizing capacity) of an individual have been mentioned [6]. There are whole chapters dedicated to information on dietary items that are best for consumption and contra-indicated in daily consumption or certain conditions referred to as *Agryadravya*. Considering the essentiality of food for life, the classical literature in Ayurveda delineates a lucid description of adverse reactions occurring due to single drugs and compound formulations along with dietary recipes.

WHO defines pharmacovigilance as the science and activities related to detecting, assessing, understanding, and preventing adverse effects or any other possible drug-related problem [7]. It plays a pivotal role in ensuring the safety of drugs and health supplements. There has been an exponential increase in the demand for OTC (over-the-counter) drugs steadily over these years globally and in India [8]. Traditional medicinal systems possess a rich cultural background and have a comprehensive yet personalized approach to the management of diseases. India has a unique blend of different well-acknowledged traditional systems of medicine, such as Ayurveda, Siddha, Unani, Yoga, naturopathy and homeopathy. In the community, traditional medicines are often considered herbal over-the-counter (OTC) products. But there is a clear distinction between traditional medicine and herbal products. The evidence for pharmacovigilance stands deficient for OTC products.

Regarding dietary supplements, a new classified section of vigilance, namely 'nutravigilance' is emerging slowly. The following chapter highlights some excerpts from Ayurveda classics wherein the concept of vigilance of diet has been addressed.

## METHODOLOGY

In this chapter, an attempt has been made to collate all the references from the three major classical treatises *viz.* *Charaksamhita*, *Sushrutasamhita* and *Vagbhata*, are collectively called *Brihatrayee*. Information has also been mined from treatises like *Sharangdhar Samhita*, *Bhavprakashasamhita*, *Madhav nidana* and *Yogaratanakara* by emphasizing the vigilance aspects related to dietary items. Data has also been extracted from various *Nighantus* (lexicons), which provide detailed information on single drug properties, posology, therapeutic usage and adverse reactions, if any. The data has been classified based on the vigilance

starting from collection and cultivation practices of food items, its processing techniques, food incompatibilities, disease-specific dietary restrictions, prakriti-specific diet, code of conduct, *etc.*, extracted and organized systematically, and observations have been noted down.

## OBSERVATIONS

### Food Collection Practices

Special emphasis has been laid on the collection practices of grains which are a part of our staple diet. Grains, especially rice harvested in unusual seasons, infested with disease, immature in nature, and germinated stage, have been mentioned to cause indigestion and ocular problems [9]. Grains that are contaminated, affected by frost, breeze, sunlight, and polluted air, stored in areas of reptiles, infested with worms, and not grown in the fields meant for other kinds of grains have been contra-indicated for use. In the case of vegetables, very tender vegetables have been contra-indicated for use. It has also been advocated to avoid consuming vegetables and fruits subjected to prolonged exposure to the sun, and wind, kept in unhygienic storage conditions, exposed to an excessively dry climate and cultivated in unusual seasons. The same is applicable in the case of the consumption of fruits [10]. In the case of meat products, the flesh of the diseased, old, or emaciated animal has been termed unfit for eating.

### Processing Techniques

According to Charakasamhita, vegetables like *Suvarchala-Malva rotundifolia* Linn. (*Malvaceae*), *Nishpava (Lalab purpureus)*, *etc.*, should be first boiled in water, thereafter should be sauteed with oil after discarding water. Some vessel-specific usage instructions have also been enumerated. Yusha (soup), Peya (porridge), and Rasa (~shorba) must be stored in Silver vessels Khala (generally, drugs are pounded and cooked in buttermilk.), Katvara (curd is churned without adding water along with butter), Kambalika when used in a bronze vessel, Ghee in iron vessels, boiled milk in a copper vessel, drinking water, syrups and boiled milk in Mud/ Glass vessels when ingested prove useful to health [11]. Conversely, storage of curd in copper vessels and grape wine in brass/copper is harmful. Ghee kept in bronze vessels poses a threat that is evident in a survey study [12]. Honey must never be subjected to heat as it becomes poisonous. It has been proved that when subjected to heat, honey produces hydroxy methyl furfural, which has detrimental effects on the body. Higher concentrations of HMF indicate poor storage conditions, too [13]. Similarly, wheat must not be cooked with sesame oil as it manifests ocular problems. The incomplete formation of curd is harmful to the body and can lead to inflammatory disorders. No validation studies have been reported to date.

## Ethnobotanical use of Ayurveda to Treat COVID-19-Induced Respiratory Disorders

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**Abstract:** Respiratory tract infections are a major health problem in the entire world, especially due to corona epidemic in late 2019. Coronavirus spread-out throughout the world, and it causes the death of millions of people due to the precipitation of severity in respiratory disorders like respiratory neuromuscular, pulmonary vascular, and lung parenchymal disorders. All are the characteristic features of COVID-19 infection. The aim of the present review work was to summarize all existing ethnobotanical data on ayurvedic medicinal plants used in the treatment or management of respiratory disorders. Many known plant species are traditionally used to treat respiratory disorders & some plant species have been investigated for their therapeutic efficacy with positive results. This present study explored various offline & online databases for the literature on ayurvedic medicinal plants used worldwide to treat & manage respiratory disorders. A total number of 205 ayurvedic plant species used to treat & manage respiratory disorders worldwide has been documented. Most of the plants belong to *Solanaceae*, *Asteraceae*, *Amaryllidaceae*, *Lamiaceae* & *Malvaceae*.

**Keywords:** Ethno-medicinal, Respiratory disorders, Herbs.

### INTRODUCTION

After screening on the basis of infection throughout the world, W.H.O. has declared that COVID-19 is a pandemic [1]. An epidemic is defined as any disease developing across a huge geographic region and affecting a huge population [2].

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The latest epidemic reputed worldwide was the H1N1 flu in the year of 2009. On 31<sup>st</sup> December 2019, a number of cases related to pneumonia for an unknown reason in the city of Wuhan, China, were reported to the WHO. In January 2020, a previously unknown new virus strain was detected [3]. Those viruses belong to the family of coronaviruses that have symptoms like respiratory diseases or gastrointestinal diseases [4]. Respiratory disease starts from the common cold to severe lung diseases.

A new & noble strain of coronavirus has yet to be identified in humans [5]. Scientists later identified a new strain of coronavirus and named it COVID-19. The virus that causes this disease was previously known as SARS-CoV-2.

### CONSEQUENCES OF CORONAVIRUS INFECTION

COVID-19 virus affects the respiratory system of people. Some individuals who are infected with COVID-19 do not have any symptoms [6]. Some other persons have mild to moderate symptoms. Only 1-2% of the population will suffer from pneumonia. Viral pneumonia is the most serious symptom of COVID-19; it develops a cough, fever, hypoxemia, dyspnoea & bilateral infiltrates on CT-SCAN [7]. Severe hypoxemic respiratory failures result in acute respiratory distress syndrome in those patients who suffer from COVID-19-induced viral pneumonia. Patients needing ventilators are at a high risk of death (Fig. 1).

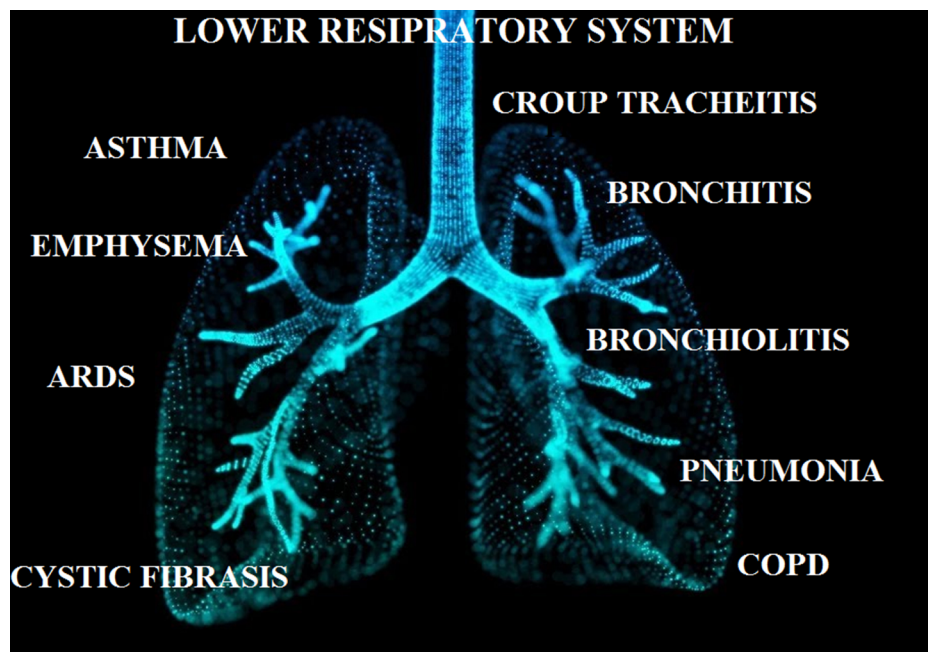


Fig. (1). COVID-19 infection induced respiratory disorders.

## EFFECT OF COVID-19 INFECTION ON THE RESPIRATORY SYSTEM

The human lungs epithelium respiratory airway is composed of different type of cells containing epithelial non-ciliated & ciliated cells, goblet cells which are primarily responsible for the secretion of mucus that makes the primary barrier for a virus, club cells-which involves producing proteases [8]. Different types of respiratory viruses bind & contaminate non-ciliated or ciliated epithelial cells. COVID-19 infects human ciliated epithelial cells, and viruses, including influenza, infects non-ciliated cells. Existence of receptors on the host cell that is responsible for virus attachment and their entry for which host cells become infected [9]. ACE-2 receptor is a primary site for SARS-CoV along with human coronavirus NL63, whereas the MERS virus binds with the human dipeptidyl peptidase-4 receptor [10]. Influenza viruses predominantly bind with sialic acid as their receptor, whereas avian influenza directly attached  $\alpha$ -2,3-linked oligosaccharides with sialic acids. Cells found in the respiratory airway tract shows viral receptor is important for the beginning of virus infection and its clinical demonstration. In difference, if the receptor is placed on the lower respiratory system, the virus causes infection in the lowers respiratory tract [11]. After binding with the receptor, the virus gets access to reach inside of the cell & uncoated its genome, unleashing the viral genetic material [12, 13]. Viruses use host mechanisms for their development *via* transcription & translation processes and produce specific cellular compartments and genetic materials [14, 15]. All produced viral materials are joined together, forming a new virus ready to infect new healthy cells [16, 17, 23].

## IMPORTANCE OF MEDICINAL PLANT

Ayurveda contains an alternative Indian medicine system in which thousands of medicinal plants are reported for their pharmacological activity. It is now understood that the plant consists of a broad range of phytochemicals that have the potential for the treatment of challenging diseases or disorders. A number of research papers revealed the value of medicinal plants like cardiac glycosides, podophyllotoxin, *etc.* [18, 19]. Extensively, medicinal plants can be widely categorised into those with anti-inflammatory, antiviral and immunomodulatory effects [20], antiviral effects with reported anti-inflammatory activities may play an important role in the management of COVID-19 inflammatory markers like IL-6, ESR, and CRP associated with severe disease COVID-19 patients, most likely interrelated to cytokine storm [21, 22]. Table 1 includes a list of Ayurvedic plants used in the treatment of COVID-19-induced respiratory disorders.

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**CHAPTER 8**

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**Folk Knowledge and Ethnobotanical Practices in Tripura, India: A Special Focus on Plants used in the Management of Pain, Inflammation and Wound****Saikat Sen<sup>1,\*</sup> and Raja Chakraborty<sup>2</sup>**<sup>1</sup> *Faculty of Pharmaceutical Science, Assam Down Town University, Panikhaiti, Assam – 781026, India*<sup>2</sup> *Institute of Pharmacy, Assam Don Bosco University, Tapesia Gardens, Kamarkuchi, Sonapur, Assam 782402, India*

**Abstract:** Plants are an important source of modern medicine. Ethnic communities/rural people largely depend on the folk medicinal system that is not documented systemically but could play a key role in drug discovery. Ethnobotanical surveys are an important tool to extract such knowledge from people transmitted mostly verbally from generation to generation. Tripura is a small state in India but is considered a storehouse of important medicinal plants. Different tribes and local people of Tripura use numerous plants in their daily life to meet medicinal needs. Several ethnobotanical surveys were conducted in Tripura and documented the medicinal use of plants. Pain, inflammation and wound are a few common problems associated with our daily life. This chapter focused on the traditional medicinal plants used in the treatment of pain, inflammation and wound by the people of Tripura.

**Keywords:** Tripura, Ethnobotany, Medicinal plants, Pain, Inflammation, Wound.

**INTRODUCTION**

Mother nature has always provided resources for our existence and for the development of civilization. Plants have been an important source of food, medicine, shelter and other needs from time immemorial. Our dependency on plant sources for medicine since ancient times has provided the backbone for current scientific progress in drug development [1, 2]. The development/use of plant-based medicine is well noted in old medicinal texts worldwide, and such importations are still playing a key role in investigating novel therapeutic agents.

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It was estimated that out of 2.5 lack higher plant species, only 5–15% had been investigated scientifically. Herbal medicine is considered the root of modern medicine [1, 2]. It was estimated by the World Health Organization (WHO) that the majority of the world's population lives in underdeveloped or developing countries and still uses traditional medicine for their regular healthcare need. Plants are always the crucial source of therapeutic agents, and in recent years, the demand for herbal medicine has been increasing significantly throughout the world [1, 3].

### **FOLK KNOWLEDGE AND ETHNOBOTANY**

Codified traditional knowledge like Ayurveda, Siddha, and Unani systematically recorded the use of plants for different therapeutic purpose, but in the non-codified system (like folk/indigenous medicinal system), information related to the therapeutic use of plants were not recorded but practiced among the specific group since thousands of years. Ethnic/indigenous or local communities congregated such information from their ancestors and still practice with any properly written documents [2, 3]. It was estimated that more than 7500 plants are used by the ethnic/indigenous/local communities of India for their regular medical need. More than 25,000 plant-based formulations are in use among ethnic/indigenous people for medicinal purposes [3].

John Harshberger introduced the term ‘ethnobotany’ first in 1896, described “the study of plant use by humans”. Ethnobotany studies always focus on the intimate dependency of people on plants. The relationship between people and plants available in the surroundings, and detailed observation of the use of plants for medicinal, cultural, and other needs, are the key focus of the ethnobotanical survey. The importance of information shared by the people has been recognized widely in modern scientific societies [4]. Folk knowledge and ethnobotany provide important information in modern scientific investigations focusing on new drug development. The importance of ethnomedical knowledge is also acknowledged primary health care system. Modernization, industrialization, the destruction of forests, and the loss of ethnic cultures and customs are challenges to documenting folk knowledge. The use of ethnomedical information in the discovery of plant-derived drugs will continue to play a key role. In the process of a new drug investigation, ethnobotany can play an important role by providing evidence about the possible indication of a specific plant during the screening of its bioactivity. Ethnobotany can also play an important role in the conservation of medicinal plants and in protecting intellectual property rights [5, 6].

### **TRIPURA & ITS ETHNOBOTANY**

Tripura is the third smallest, hilly state of India and an important storehouse of diverse species of flora and fauna. The state is known for its valued heritage of

traditional medicinal knowledge and repository of medicinal plants. Tripura is located in the bio-geographic zone of 9b-north-east hills and enjoys a very rich bio-diversity. Tripura is considered the gateway to faunal and floral confluence as the state lies geographically between Indo-Malayan and Indo-Chinese biological realms. Tripura is one of the eight states of North East India, which is also part of both Himalaya and Indo-Burma biodiversity [7]. Floral diversity is significant in Tripura; nearly 1463 of the 17,000 species or 8.6% of angiosperms (flowering plants) of India are recorded in Tripura, although geographical land is only 0.3% considering the total land of India [8]. Indigenous people accumulated knowledge based on their need, observation, trial and error, instinct, *etc.* Such knowledge, particularly about the medicinal uses of plants, is vital in the society of those people, and they generated, refined and transferred knowledge to the next generation for thousands of years [9]. In Tripura, 69% of the population are Nineteen different tribes, and many subgroups are inhabited in Tripura; each of them has its distinct dialect and culture. Indigenous and rural people of Tripura possess rich traditional knowledge and utilize different plants in daily life for medical needs [7, 9]. Table 1 includes brief details of the geographical area, forest cover, ethnic diversity and biodiversity profile of Tripura.

**Table 1. Geographical area, forest cover, ethnic diversity and biodiversity profile of Tripura.**

Total Area	Forest Cover	Population	Climatic Condition	Ethnic Diversity
10486 sq. km Located between 22°7' and 24°2' North latitudes and 91°0' and 92°0' East longitudes	7726 sq. km (73.68% of total geographical area)	36,71,032 (as per Census, 2011)	Warm and humid tropical climate with distinct seasons, namely, spring, summer, monsoon, autumn and winter. Average rainfall: 2250 mm to 2500 mm. Temperature: 21-38°C in summer & 4-33°C in winter.	Schedule Tribe Population is 31.8% of the total population. Major tribes are tripura or tripuri or Tippeara, Reang, Jamatia, Chakma, Halam, Noatia, Mog, Kuki, Garo, Munda, Lushai, Orang, Santhal, Uchai, Khasia, Bhil, Cheimal, Bhutia, and Lepcha.

## ETHNOMEDICINAL PLANTS OF TRIPURA FOR MANAGEMENT OF PAIN AND INFLAMMATION

Inflammation is a usual, defensive response to tissue injury, and pain is considered an unpleasant experience related to tissue damage comprising sensory, affective, and cognitive components. A number of disease conditions are associated with pain and inflammation. Many plants have been investigated scientifically to find better drugs to address such a situation, and ethnobotany always plays a key role in this process. Drugs used to reduce pain and



## CHAPTER 9

## An Ethnobotanical Study of Medicinal Plants Used by the Ethnic Group of People of the District of North 24 Parganas, Howrah, Kolkata, West Bengal, India

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**Abstract:** The knowledge of medicinal plants, historically, was occupied by a few specialized herbal healers in rural communities; thus, much of their use was observed as being primarily of local interest. For the past couple of decades, medicinal plants have been increasingly recognized for their role in health care and improving economic status. India is one of Asia's largest countries, with the richest arrays of well-known medicinal plants and alternative medical systems, including Ayurveda. The medicinal plants are used as traditional medicine by the indigenous people of North 24 Parganas, Howrah and Kolkata. The study aimed to identify the plant species used as traditional medicines by natives in North 24 Parganas, Howrah and Kolkata, and also to describe the method of preparation and uses of some medicinal plants. This research was conducted in three districts of west Bengal. The information recorded includes methods of treatment of disease, Tribal names of plants they used for treating various diseases, parts of the plant used, preparation and mode of application, and whether the plant is used alone or in combination with other plants. Results indicate that the indigenous people in those districts have been using at least 33 plants as a source of medicine. Most of these medicinal plants are commonly gathered from local areas. Common diseases like fever, cough and cold, constipation, hypertension, tuberculosis, wounds, *etc.*, can be treated using medicinal plants from those three districts. Research also found that all parts of plants are used, but leaf extracts are the most common parts of the plant used for treating medical conditions.

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**Keywords:** Medicinal plants, Herbal healers, West Bengal, Traditional medicine, folk medicine.

## INTRODUCTION

The imposition of herbs and natural arrangements, especially those dependent on a regular medication framework, is expanding into people's daily routines as a global community seeks effective, relatively safer, and better drugs. As the World Health Organization (WHO) reported, around 80% of the total population, especially people in rural areas, depend on herbal medicines for basic health care [1]. Medicinal plants, also called medicinal herbs, have been discovered since prehistoric times and are used in traditional medicine. In herbivorous mammals, plants synthesize hundreds of chemical compounds for functions such as repelling insects and fighting infection and metabolic disease [2]. However, since a single plant contains very different phytochemicals, the effects of using a whole plant as a medicinal product are uncertain. Ethnic groups of people have a living knowledge of the biotic resources of conventional medicinal plants, which helps professionals conduct better scientific studies [3]. Herbal remedies are an important part of all officially recognized health systems in India, namely Ayurveda, Yoga, Unani, Siddha, Homeopathy and Naturopathy, except allopathy [4]. Ayurveda is a 'science of life, which contains 2000 plants used in Ayurvedic formulations and recorded as the ancient method to cure people of different diseases. Siddha (3000 BCE-2000 BCE) is the second most ancient method to cure people, which also contains 1300 plants for medicinal use. Unani is used by Arabs and Persians and also contains 1000 plants. Folk medicine is a medicine of tribal people or indigenous people, which contains 5000-8000 plants used to prepare folk medicine [5]. Our work was concentrated on folk medicine which contains a broad category of plant species that can be used as medicine. West Bengal is a federal state in eastern India. The total area covered by the state is 88,752 km<sup>2</sup> between the Himalayas and the Bay of Bengal [2]. Techniques such as a semi-organized meeting, a close and personal speech, a group discussion, and a field perception were carried out to obtain information on restorative plants from ancestral and non-ancestral drug practitioners of various positions and religions in the study region. The information about the plants was collected along with their detailed mode of application. The phytochemical content and pharmacological actions of many plants with medicinal potential are unaffected by rigorous scientific research to define efficacy and safety. In India, over 77% of people use Ayurveda, other than herbal medicine, for Primary healthcare [6]. In China, traditional herbal drug accounts for up to 30-50% of the total medicinal compounds. While in Africa, 90% of the population uses traditional medicine for primary health care [1, 7]. In the African countries of Ghana, Mali, Nigeria, and Zambia, Herbal medicines are the 1<sup>st</sup> treatment for 60% of children with high

malaria fever. Whereas in San Francisco, London, and South Africa, 75% of people living with HIV/AIDS use Traditional medicine [5, 8, 9].

Over 70% of India's 1.1 billion people still use these non-allopathic systems of medicine<sup>9</sup>. Conventional local healers extensively used natural sources and rationed the connection between human culture and conditions. Herbal treatments are exceptionally well known worldwide because they contain many bioactive molecules to treat different infections and are also considered safe compared to drugs [10-12]. Data has been collected and stored on the information and also on the practice of these individuals. Data on plant species, such as close name, portions of the plant used, therapeutic significance, method of arrangement, and use, were collected and archived. All the examples of plants were collected during the different seasons. The plants were recognized using the standard manual; the redaction was also accessible with the help of a conventional clinician, followed by an affirmation with leading plant taxonomists. Plants were recognized utilizing standard manual, accessible writing with the assistance of conventional clinical specialists, followed by affirming with master plant taxonomists.

## **METHODOLOGY**

### **Study Location and Duration**

North 24 Parganas is the district of West Bengal that lies between 22.6168 degrees north and 88.4029 degree east, with an area of 4094 sq. km ([https://en.wikipedia.org/wiki/North\\_24\\_Parganas\\_district](https://en.wikipedia.org/wiki/North_24_Parganas_district)). In the east, it is spreading approx. 230 km extended to the international Bangladesh border. The study area is mentioned in Fig. (1).

The district has an interesting combination of people in this survey of traditional uses of some plants in North 24 PGS for the treatment of basic diseases. The information was collected from tribal men and women through face-to-face interviews, group discussions, and field observation, as shown in Fig. (2).

After interacting with the local people, we collected the plant's data, which belongs to the different families listed with the botanical name, family, local name, parts of the plant used, medicinal importance, mode of preparation and uses.

## A Comprehensive Review on Anticancer and Antitumor Potentials of Indigenous Plants Found in North East India

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**Abstract:** Cancer is a malign disease that accounts for about 9.6 million deaths around the world and is the second largest leading cause of death after cardiovascular disease. Chemotherapeutic drugs administered to treat cancer show great potency but falter, causing many severe side effects. Hence, the paradigm of cancer drug research has shifted towards plant and plant-derived natural compounds as they are reported to deliver maximal effectiveness with lesser side effects. Indigenous plants and their derivatives have been an integral part of ethnomedicine in India. The traditional knowledge of utilizing medicinal plants has been used to treat numerous metabolic disorders and diseases since immemorial. Indigenous plants have also been shown to possess high potency in the treatment of cancer as well. The natural landscape of northeast India has some of the most diverse and unique plant species, which have been traditionally used in ethnomedicine and have been studied for their anticancer and antitumor potentials. The aim of the present review is to highlight some of the natural and indigenous plant species of Northeast India that have been reported to have anti-cancer and anti-tumor effects identified either *in-vivo* or *in-vitro*.

**Keywords:** Anticancer drugs, Cancer, Ethnomedicine, Indigenous, Northeast India, Traditional.

### INTRODUCTION

Cancer is an expansionist disease, which expands stealthily both within the body

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and among the population. It has become the major cause of the disease burden of the twenty-first century. Globally, cancer ranked second in terms of disease burden, with an astounding rise in its cases of about 19.3 million in 2020, with approximately 10 million people dying of cancer in 2020 [1]. The International Agency for Research on Cancer (IARC) estimated that 1 in 5 people develops cancer during their lifetime, with 1 in 8 men and 1 in 11 women dying from this malady [2]. These grave statistics signify the expanding nature of cancer in the human population. Despite the capricious nature of cancer, many outstanding interventions have been developed to combat the disease in the form of chemotherapy, immunotherapy, radiotherapy and surgery. The treatment regime for cancer involves the possible combination of all these therapies, with chemotherapy as the most extensively used therapeutic intervention for cancer. Significant results have been found with the use of chemotherapeutic drugs with the increase in the survival rates among cancer patients nonetheless, there are some setbacks related to the use of chemotherapy. Chemotherapeutic drugs which are derived synthetically (5-fluorouracil, cisplatin, and doxorubicin) have the potential to kill cancerous cells with their anti-proliferative, anti-angiogenic and cytotoxic activity, but one drawback is that it also kills the neighbouring normal dividing cells. Hence many side effects of hair loss, anaemia, fatigue and thrombocytopenia have been associated with the use of chemotherapeutic drugs. Prolonged use of chemotherapeutic drugs also causes irreversible damage causing kidney dysfunction, peripheral neuropathy and heart problems. Therefore, there is a dire need for a potent bioactive compound that could kill cancer without harming normal cells. Complementary and alternative therapies (CAM) involving medicinal plants and herbs have paved a new path in cancer treatment [3]. Studies have shown that natural plant-derived bioactive compounds are effective against cancerous cells *in-vitro* and *in-vivo* models [4]. Scientists around the world are on the hunt for potential medicinal plants and their bioactive compounds that possess anti-cancer activity with nominal side effects. Medicinal plant derivatives have gained momentum as they are readily available in nature, can easily be absorbed by the body, and are relatively less toxic to normal healthy cells. In addition to that, plants contain secondary metabolites such as flavonoids, saponins, phytosterol, coumarins, terpenes, alkaloids, isocatechins, lignans, and catechins, which has shown anti-cancer and immunoprotective activity against cancer [5].

The use of plants and their compounds is an integral part of traditional medicine which has been practiced extensively around the world since time immemorial. According to World Health Organization (WHO), about 80% of the total world population is still using traditional herbal medicine as the primary health treatment or health care need [6]. India is referred to as “Emporium of Medicinal Plants” [7], as the Indian sub-continent housed more than 8000 medicinal plant species and are the largest producer of medicinal plants in the world [8]. In India,

plants are used as a part of Ayurveda, the oldest medicinal system, and folk medicine, primarily for the treatment of chronic and infectious diseases by tribal and indigenous people. The North-eastern region of India, comprising the states of Nagaland, Tripura, Meghalaya, Assam, Arunachal Pradesh, Manipur, and Mizoram, is one of the 25 global biodiversity hotspots, blessed with unique indigenous plant species due to its topological and climatic features such as high rainfall, high humidity, and moderate temperature surrounded by the dense forests, marshes, and swamps [9]. The diverse and indigenous plant population of North-east India has been reported to possess medicinal properties and bioactive compounds that can be used against cancer as an anticancer drug. For instance, the bioactive compound taxanes (Taxol/paclitaxel), an anticancer drug used against breast, ovarian, and lungs cancer, is extracted from *Taxus baccata* L. (Pacific Yew) are found abundantly in the north-eastern states of Meghalaya, Arunachal Pradesh and Manipur, and central Himalayan regions which have the highest yield of taxol [10]. Another example is Curcumin, a bioactive compound found in the *Curcuma longa* (Turmeric) that has shown anti-tumor and anti-proliferative activity against various cancers of the breast, lung, prostate and brain [11]. The lakadong variety of *Curcuma longa* found in the Jaintia hills of Meghalaya has a curcumin concentrate of about 6-7% as compared to 2-3% in most varieties of turmeric [12]. It perhaps could be used as a potent source to treat cancer. These medicinal plants are an indispensable part of the ethnomedical treatment practices in the northeastern regions. The phytoconstituents of these medicinal plants have the utmost potentials that can be used to curate an effective treatment to combat cancer. The aim of the present chapter is to exclusively explore the therapeutic potentials of major plant-derived compounds of some unique medicinal plant species found in the north-eastern region of India, which has been well-investigated for their anticancer activity also shedding light on their possible mode of action.

## MEDICINAL PLANTS AND THEIR ANTICANCER ACTIVITY

Extensive research has been made to evaluate the phytoconstituents of plant-derived compounds. Plants that have successfully targeted cancer effectively through their mechanistic studies done in *in-vitro* and *in-vivo* anticancer models have been elucidated extensively and presented in Table 1, along with their characteristic anticancer activities.

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## Raja Chakraborty

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Dr. Chakraborty, M.Pharm, Ph.D., FICS, currently holds the position of professor and head of the department at the Institute of Pharmacy, Assam Don Bosco University, Guwahati, Assam, India. He has a vast teaching and research experience of over 15 years in various pharmacy colleges and universities approved by the Pharmacy Council of India (PCI), where he has made significant contributions to the field. Dr. Chakraborty has an extensive publication record, including authored/edited books, and contributions to peer-reviewed edited books. His research and review articles have been published in reputable journals. He has also been involved as a co-principal investigator (co-PI) in an externally funded project. His research interests encompass medicinal chemistry, traditional medicine, chemical profiling of phytochemicals, metabolic disorders, and oxidative stress. Furthermore, he has successfully supervised the research work of three Ph.D. scholars. Recognizing his exceptional teaching skills, Dr. Chakraborty was honored with the APJ Abdul Kalam Award for Teaching Excellence in 2018, by Marina Labs Chennai. Additionally, he received recognition from the Journal of Forestry for having the best-cited article of the year. Dr. Chakraborty has also completed a significant networking project on scented Rice of North-East India, sponsored by the Department of Biotechnology (DBT) under the Indian government.



## Saikat Sen

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Saikat Sen, M.Pharm, Ph.D, FICS, FBSS is a Professor, Assam down town University, Guwahati, India. He has a B.Pharm degree from JSS College of Pharmacy, Ooty, a Master's degree in Pharmacology from the College of Pharmacy, Sri Ramakrishna Institute of Paramedical Sciences, Coimbatore, and Ph.D. degree in Pharmaceutical Sciences from Jawaharlal Nehru Technological University Anantapur, Andhra Pradesh. He has written two books, edited three others, and contributed to various peer-reviewed edited books published by renowned publishers worldwide. He has published over 80 research and review articles in highly reputed national and international journals. Dr. Sen has presented multiple scientific papers, attended numerous national and international conferences, and has given invited lectures at various scientific events. He is affiliated with various professional organizations and journals in roles such as Life Member, Fellow Member, Scientific Advisor, Editorial Board Member, Advisor Board Member, and Reviewer. With a teaching and research career spanning more than 15 years, he has a deep understanding of the latest research on natural remedies and their ability to treat various health conditions. He has dedicated a considerable amount of time to studying traditional medicine, with a specific emphasis on herbal medicine. He has been honored with multiple awards for his contributions, including the "Dr. APJ Abdul Kalam Award for Young Scientists 2018" from Marina Labs in Chennai, the "Best Faculty Award" from The Science & Technology Awards (STA-18) in 2018, and the "Sushruta Best Young Scientist Award" from Bose Science Society in Tamilnadu in 2019. In addition, he was recognized with a reward from the Journal of Forestry Research. Furthermore, in 2022, he was awarded the "Best Teacher in Responding and Executing Task" at Assam down Town University. Under the sponsorship of the Department of Biotechnology (DBT) of the Indian government, he has accomplished a significant networking project on Scented Rice of North East India. He is also supervising the doctoral research of several PhD scholars. He is actively engaged in scientific research on traditional and folk medicinal systems, and is committed to promoting a vibrant research culture.