

## Citraka (*Plumbago zeylanica*): A Potential Rejuvenator

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### ABSTRACT

*Plumbago zeylanica* is also known as chitraka, doctor bush, or leadwort. It is the most popular herbal plant that belongs to the family *Plumbaginaceae* or *leadwort*. Plumbagin is the most important chemical constituent present in the roots, leaves and stem of the plant that is responsible for various pharmacological actions including anti-malarial, anti-obese, anti-diabetic, anti-microbial, anti-ulcer, anti-inflammatory, anti-oxidant and anti-cancer. Traditionally it is used to treat variety of diseases such as dysmenorrhea, leprosy, anemia, rheumatic pain, cold, cough, arthritis and many more. It is considered as the most significant herbal plant in the ayurveda medicinal system of India and is widely accepted as a rejuvenator because of the presence of bioactive compounds. Various formulations of chitraka plant have made this plant more effective in the field of medicine. The plant carries various therapeutic properties and acts as a cardiogenic, neuroprotective and CNS stimulant. The review aim is to provide data or information related to chitraka plant its usage in traditional and ayurveda medicinal system, its pharmacological properties and toxicity when taken in excessive amount. From the collected data, it is clear that the plant has great potential to cure various diseases and needs more research and development to explore its more pharmacological properties and socio-economic impact.

**Keywords-** Chitraka, Anticancer, Ayurveda, Rejuvenator, Pharmacological property.

### I. INTRODUCTION

Herbal plants play an important role in pharmaceutical industries. 50% of the modern drugs are synthesized from herbal plant origin as per reported studies [1]. The usage of medicinal herbal plants is increasing worldwide [2]. Most people depend upon herbal medicines as they are non-toxic with fewer side effects [3]. According to a reported study, WHO is encouraging developing countries to use herbal or ayurvedic medicines [4].

*Plumbago zeylanica* commonly called chitraka, chitramoolam doctor bush, or leadwort is the popular medicinal plant that belongs to the family *Plumbaginaceae* also referred as *Plumbago* family or *leadwort* family [5]. The generic name *Plumbago* is derived from the Latin word *Plumbum* which means 'lead', refers to the plant ability to treat lead palsy or the

ability of plant sap to form lead-colored stains on the skin [6,7] and *zeylanica* means 'of Ceylon'. The genus *Plumbago* consists of 3 species named *Plumbago indica*, *Plumbago capensis* and *Plumbago zeylanica* that are distributed in several parts of India. This plant is considered as the multipurpose medicinal herbal plant, which is used in the traditional medicinal systems like Ayurveda and Siddha medicinal system for over 3000 years. The plant is native to southeast Asia and is grown in tropical and subtropical regions up to an altitude of 2000m [8-11]. Traditionally, the roots of this plant are used to cure diseases like headache, body pain, fever, muscular pain, rheumatic diseases, inflammation and also acts as a stimulant digestant, expectorant and laxative [12]. In Ayurveda and Unani medicinal system, it is used to treat diseases like rheumatic pain, sprain, scabies, anemia, dysmenorrhea, carbuncles, leprosy, ulcers, inflammation and elimination of intestinal parasites [13-18]. In India, it is mainly used to cure fever, malaria, dyspepsia, piles, diarrhea and skin diseases [19]. The main active constituent of the PZ plant is Plumbagin found in the root part of the plant. The plant possesses various pharmacological properties like antidiarrheal [20], anti-allergic, insecticidal, antidiabetic [21], hepatoprotective [22], hypolipidemic [23], anti-inflammatory, antitumor [24], antibacterial, antimalarial and antifungal activities [25,26]. Chitraka plant is known by various folk names in different states of India and in other countries as shown in table no. 1. The taxonomical classification of chitraka plant is shown in table no. 2.

**Table 1: Vernacular names of *Plumbago zeylanica* [27]**

Hindi	Chitraka, chita, Chitramol, chiti, chitra [28,29,30]
Gujarati	Agni / vahini, Chitro, chitra, pitaro, chitrak, chitrakmula [31,32]
Kannada	Chitramula, vahini, Pellichitramool, chitramulika, Bilichitra [33]
Malayalam	Chitrakmula / bilichitramula, Thumpo Koduveli, Vellakoduveli, Tumba koduveli
Punjabi	Chitra, Chitrak [34]
Bengali	Chitra, Chita, Chitak, Safaid chitarak
Tamil	Chita, Adigaarradi, Akkini,

	Angodiveli, Chitramoolam, kanilam, Tigana, Vengodi, Veli, Sittaragam, Kanilam, Sittramulam, Sadaveda, Koduveli
Telugu	Kodiveli, Chitramoolam, Agnimata, Tellachitramulamu, Tella chitra
Sanskrit	Chitra, Agni, Vahni, Krishanu, Huashaa, dahana, hutabhuk
Urdu	Sheetraj Hindi, Cheetah, Chitalakri
Marathi	Chitraka, Chitramula
Oriya	Chitamulo, Chitapru, Krisanu, Ogni [35]
Assamese	Agiyachit, Agnachit, Boga agechita
Kashmiri	Chitra, Shatranja
Manipuri	Telhidak Angouba
English	Lead wort, Ceylon lead wort, doctorbush, White flowered leadwort
German	Bleiwurz, zahnkraut, Ceylo-nische Bleiwurz
Swahili	Sanza
Arabia	Ensain, Enkin, Shitaraj
Nepal	Chitu



Figure 1: *Plumbago zeylanica* (chitraka)

Table 2: Taxonomical classification of Chitraka [36,37]

Taxonomical Rank	Taxon
Kingdom	Plantae
Sub-kingdom	Tracheobionta
Division	Magnoliophyta
Sub-division	Angiosperms
Class	Dicotyledonae
Sub-class	Gamopetalae
Order	Caryophyllales / Primulales
Family	<i>Plumbaginaceae</i>
Genus	<i>Plumbago</i>
Species	<i>Zeylanica</i>
Common name	Citraka

## II. BOTANICAL DESCRIPTION OF PLUMBAGO ZEYLANICA

The *Plumbaginaceae* family consists of 280 species and 10 genera. It is a rambling sub-scandent perennial dicot herb or designated as a shrub which is grown in shady places [38,39].

**Root:** The roots of *P. zeylanica* are stout, cylindrical, friable, slightly branched or straight unbranched with or without secondary roots have a smooth and uniform texture. It is blackish-red in color, reddish-brown when dry, light yellow colored when fresh, 30cm in length and 6mm in diameter. It has a specific odor and bitter taste [40].

**Stem:** Stem is glabrous, spreading, somewhat woody, terate and striated reaches up to the height of 0.5 -2m. The bark is thin and brown [41].

**Leaf:** Leaves are simple, elliptical with hairy margins ovate or oblong, dark green alternate with 8cm in length and 3cm in breadth. The petiole is thin, narrow, amplexicaul at the base and dilated into stipule. -like auricles.

**Flower:** Flowers are white, inodorous, inbracteate, bisexual, axillary and terminal elongated spikes consist of terminal raceme inflorescence with length 10-25cm. The calyx is tubular densely covered with stalk, sticky glands, white corolla, slender, 5 free stamens with superior ovary, pentagonous, single-celled and one basal ovule [42].

**Fruit:** Fruits are oblong, capsulated, single-seeded, reddish-brown to dark brown with 7.5-8mm in length.

## III. GEOGRAPHICAL DISTRIBUTION OF P. ZEYLANICA

*Plumbago zeylanica* is native to Southeast Asia and is distributed in tropical and subtropical regions up to an altitude of 2000m. It is found throughout India in the wild state and mostly grown in Bengal, Malay peninsula, Ceylon-tropics of the old world. In India, it is mainly cultivated in districts of Andhra Pradesh, Karnataka, Maharashtra [43].

## IV. PHYTOCHEMICAL CONSTITUENTS OF PLUMBAGO ZEYLANICA

*P. zeylanica* contains secondary metabolites which include flavonoids, alkaloids, saponins, glycosides, tannins, steroids, triterpenoids, carbohydrates, coumarins, fixed oil, phenolic compounds, fats, naphthoquinones and proteins [44]. The screening of different parts of PZ plant also revealed the presence of linoleic acid, nonylnonanoate, palmitic acid, stigmasterol acetate, lupeol acetate, lupeol, friedelinol, lupanone, stigmasterol and sitosterone [45,46,47]. The leaves, stem and roots of PZ plant

contain a greater amount of microelements, (Zn, Fe, Mn, Cr and Co) macroelements (Na, K, Ca, Mg) and eight other elements which include Mo, Sb, Bi, Cd, Sr, Pb, Cd and Arsenic [48]. The chemical constituents present in the aerial part of the plant consist of plumbagin, isohinanolone, plumbagic acid, beta-sitosterol, 4-hydroxybenzaldehyde, trans-cinnamic acid, vanillic acid, 2,5-dimethyl-7-hydroxychromone, indole-3-carboxaldehyde [49]. The dichloromethane extract isolated from aerial parts of PZ plant contains beta-sitosterol, beta-sitosteryl-3 beta-glucopyranoside, beta-sitosteryl-3-beta-glucopyranoside-6'-O-palmitate, lupenone, plumbagin, lupeol acetate and trilinolein [50]. The root of the PZ plant contains different bioactive products which include plumbagic acid glucosides (3'-O-beta-glucopyranosyl plumbagic acid and 3'-O-beta-glucopyranosyl plumbagic acid methyl ester) [51] along with five naphthoquinones (plumbagin [52], chitranone, [53] maritime, [54] elliptinone and isoshinanolone [55] and five coumarins (seselin, [56] 5-methoxyseselin, [57] suberosin [58], xanthyletin [59] and xanthoxyletin [60]. Naphthoquinones present in PZ plant includes plumbagin, chitranone, 3-biplumbagin, chloroplumbagin, and elliptone. Other compounds present are saponaretin, isoaffinetin, beta-sitosterol, 2-dimethyl-5-hydroxy-6-acetylchromene, zeylanone, campesterol, isozeylanone, plumbaginol, chitranone [61]. The structures of some major phytochemicals are shown in figure no. 2.

## V. TRADITIONAL AND MODERN VIEW OF PLUMBAGO ZEYLANICA

### a) *P. zeylanica* in Ayurveda

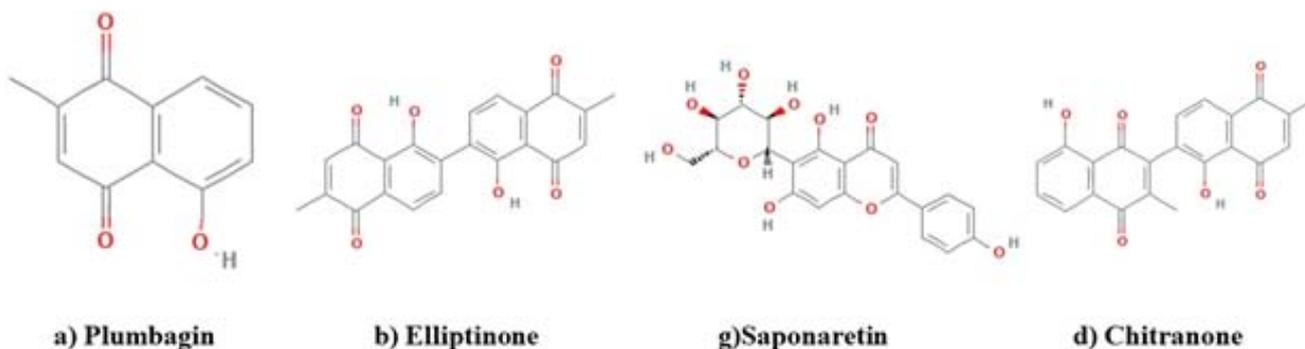
Ayurveda means the science of life that provides medicines to a large section of our population. Chitraka plant is considered as an effective herbal drug in Ayurveda medicinal system. All the parts of the plant are used to treat various diseases but the roots of Chitraka plant show highest activity in treating various ailments and disorders [62]. It increases Pitta dosha and alleviates Kapha and Vata. Ayurveda, an indigenous system of medicine has characterized chitraka as tumor –negating and anti-dyspepsia. In Charaka Samhita, it is categorized as an appetizer, anti-saturative, anti-anorexic, pain

reliever and anti-hemorrhoid [63]. The rasapanchak (properties) of Chitraka plant are shown in table no. 3.

**Root:** In Ayurveda, root and root bark has been used to treat dysentery, intestinal troubles, leukoderma, inflammation, piles, bronchitis, itching, disease of the liver, tridosha. Ascites. Milk juice of root bark is applied to ulcers and scabies [64]. Roots act as an abortifacient, vesicant, antidiarrheal, appetizing, sudorific, laxative, expectorant, alexipharmic, thermogenic, antiatherogenic, cardiotoxic, neuroprotective, nervous stimulant, diuretic, caustic, antiseptic, antiperiodic, narcotic, rubefacient, aphrodisiac, alternative or restorative (Rasayana or rejuvenator) [65,66]. It is also helpful in the treatment of anasarca, piles, leprosy, anemia, ringworm, scabies, jaundice, urinary calculi, migraine, internal abscesses, seminal weakness, insanity, vaginal discharge (cures menstrual disorders and post-partum discharge), dyspepsia, epilepsy, hysteria, obesity, nervous and rheumatic infections, indolent ulcer, asthma, cough, colic, helminthiasis, elephantiasis, impotency, laryngitis, hepatosplenomegaly [67].

**Leaves:** The leaves of *P. zeylanica* plant are used to cure infections and the digestive problem like dysentery and diarrhea. The paste of chitraka leaves is applied over painful rheumatic areas and chronic or itchy skin problems. The flower and fruits of the plant act as digestants. The decoction of the seed is used to decrease muscular pain [67].

**Formulations of Chitraka:** Pippalyadya churna made from chitraka along with other herbal ingredients helps to promote agni (power of digestion) and eliminates vayu (flatus) from koshta (gastrointestinal tract). Chitrakadya gutika (stimulates the power of digestion and metabolism), Kshirasatpalaka grita in which chitrak is the main ingredient used to treat Kapha, gulma (phantom tumor), sprue syndrome, anemia, splenic disorders and fever. Other formulations include Eldi grita, chitrakadi taila, chitrakavati, chitra katha, chitraka rasayana, chitraka swarasam, chitraka kalkam, chitraka hamam, panchakola, Varemadi, Mushkakadi, Amalakyadi, Shadushana, Trimada, Shaddharana yoga, Drakshasava, Tejovatyadi grita, chitrak swarasam, chitrak swarasam, chitrakadi avaleha, Chavikadi ghrita, Tejovatyadi ghrita.



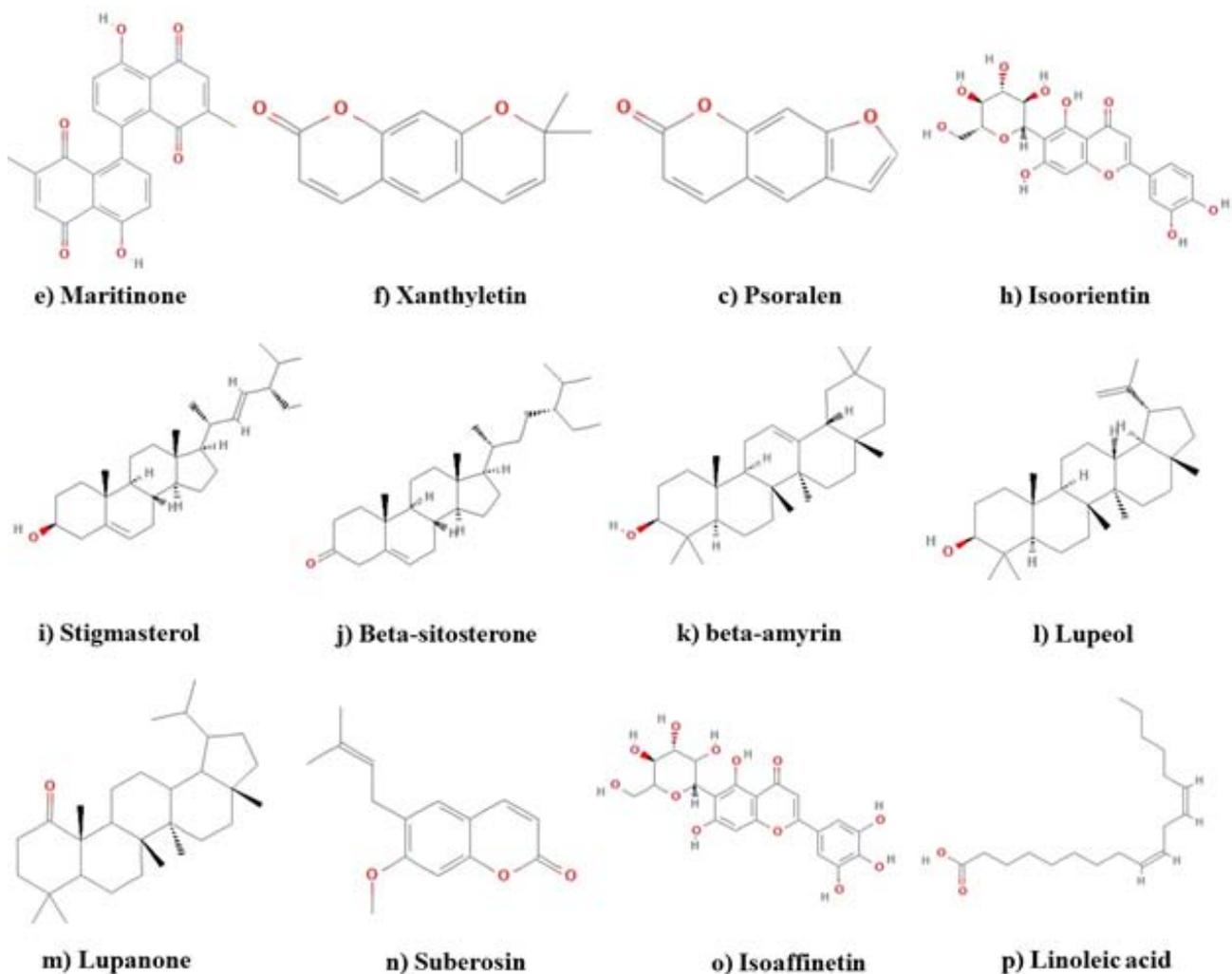


Figure 2: Chemical structures of some major phytochemicals of *P. zeylanica* plant.

Table 3: Rasapanchak (properties) of *P. zeylanica*

Veerya / Potency	Ushna / hot
Vipak / Metabolic property	Katu / bitter
Guna / Physical property	Laghu/ light, Ruksha / dry, Tikshna / astringent
Rasa/ Taste	Katu / bitter

**Karma / Action and Properties of *P. zeylanica***

Deepana: It acts as an appetite stimulant.  
 Pachana: It is used to treat digestive problems  
 Pittasaraka: It increases Pitta dosha.  
 Arshoghna: It is used to cure piles disease.  
 Grahi: It absorbs excessive fluid in intestine and binds stool.  
 Krimighna: It helps in treating ringworm.  
 Kushtahara: It alleviates skin diseases.  
 Raktapittaprakopaka: It is useful in hemorrhagic treatment.  
 Kaphaghna: It helps in removing Phlegm.

Kanthyha: It is beneficial for the throat and voice.  
 Garbhasravakara: It acts as an abortifacient agent.  
 Garbhashaya Sankochak: It helps in contracting the uterus.  
 Swedajanana: It induces sweating.  
 Jwaraghna: It is used to reduce fever.  
 Shoolahara: It helps to alleviate pain.  
 Shothahara: It acts as an anti-inflammatory agent.  
 Lekhna: It is useful in reducing fat and carries anti-obesity property.  
 Vajikarana: It is useful in promoting reproductive health and acts as an aphrodisiac agent.  
 Visphotajanana: It acts as a Vesicant.  
 Uttejaka: It is used to stimulate nerves.  
 Madak: It helps in the intoxication process.  
 Katupaushtika: It is used as a bitter tonic.  
 Rasayana: It is used as a rejuvenator or Antiaging drug.  
 Triptighna: It acts as an anti-saturative agent.  
 Stanya sodhak: It is used as lactode purant.  
 Sukra sodhaka: It increases the sperm count and its viability.

### b) Folk Uses

It is a well-considered medicinal plant in the folk system of medicine. It is effective against skin diseases, acne, sores, dermatitis, hookworm anemia, rheumatic pain, sprains, dysmenorrhea, scabies, leprosy, ulcers, inflammation, contusion of extremities and elimination of intestinal parasites. In the Indian medicinal system, it is recommended for the treatment of dyspepsia, piles, diarrhea, skin diseases and is used to increase digestive power and improve appetite [68,69]. It is also believed that root paste is effective against the filarial leg. In West Africa, the leaves and roots of this plant are used to cure gonorrhoea, syphilis, tuberculosis, rheumatic pain, wounds and swelling when mixed with lemon juice. In some regions of Africa, root paste when mixed with vinegar, root or milk showed effective results in the treatment of influenza and black water fever. Root extracts are taken orally to treat asthma, root decoction with boiled milk is used to cure inflammation of the mouth, throat and chest. In Mauritius and Rodrigues, root extract is used to cure diseases like diarrhea and dyspepsia. In India, it is mainly used to treat fever and malaria [70]. Reported studies have revealed that dry root powder is used as a curative agent against anemia due to 'stagnant blood', rheumatism, internal and external trauma, toxic swelling [71,72].

### c) Modern View

Adulteration is the major issue in today's scenario, which is faced by the Global herbal market. It is the main disadvantage in the promotion of herbal drugs and that's why people have lost faith in these medicines [73,74,75,76]. One of the most used practices is Species adulteration. In the herbal drug market species, adulteration has been suspected for quite a while [77]. It has adverse impacts on consumer health [78]. One of the most popular incidents of species adulteration is from China when kidney failure of more than 100 women occurred due to adulteration of species i.e. roots of *Stephania tetrandra*, which is an anti-inflammatory agent with the roots of a toxic plant called *Aristolochia fang chi* [79]. Many other practices are incorporated in the trade market of herbal drugs in modern times, which are directly or indirectly degrading the quality of herbal medicines. One of them is the use of artificially manufactured material that looks like the original drug. This is the most common practice of adulteration in the case of expensive herbal drugs [80,81]. Due to the presence of several adulterants, the rate of toxicity has increased and also the high cost is the associated factor of adulteration [82].

## VI. PHARMACOLOGICAL AND THERAPEUTIC USES

Various experimental and clinical studies were conducted on *P. zeylanica* plant to demonstrate its pharmacological and therapeutical properties. Some of the reported studies of chitraka plant are shown below. A

brief view of reported pharmacological studies is shown in table no. 4.

**Anti-microbial:** To identify the anti-microbial activity of *P. zeylanica* plant, the crude alcohol extract of chitraka plant was tested against E-coli and Shigella. It was found that the crude alcoholic extract of chitraka plant inhibits the growth of multi-restraint strains of E. coli and Shigella [83]. Another study was carried out in *Bacillus subtilis* cultures where the methanolic extract of chitraka plant showed antimicrobial activity [84]. It was also found that ethanolic extract of plant showed antimicrobial activity against *Staphylococcus aureus*, *Salmonella typhi*, *Pseudomonas aeruginosa* and *Bacillus subtilis* where chloroform and acetone showed moderate activity [85]. The crude extract of the leaves of chitraka plant demonstrates an inhibition zone when tested against E. coli, *Bacillus cereus*, *Staphylococcus aureus* and *Candida*, which indicates the potential anti-microbial activity of chitraka plant [86].

**Antidiabetic:** Various reported studies stated that the Plumbagin component of Chitraka plant increases the protein and GLUT4 mRNA expression and contributes to the glucose homeostasis when examined against diabetic rats [87]. Another study demonstrated that the ethanolic extract of *P. zeylanica* plant decreased the activity of glucose-6-phosphate and increased the hexokinase activity when administered orally to the streptozotocin-treated diabetic rats at 100mg/200mg/kg dosage [88].

**Anti-inflammatory:** From the reported study, it was found that the hydro-alcoholic extract of the leaf of *P. zeylanica* plant reduces edema, suppresses the NF-kappa B activation in the tumor cells when tested against carrageen an-induced raw paw edema in rats, thus showed anti-inflammatory activity [89,90,91]. The clinical study was conducted on 30 patients taken from OPD and IPD of the National Institute of Ayurveda, Jaipur to detect the anti-inflammatory activity of the chitraka plant [92]. A 4mgs of chitraka churna was given to 15 patients twice a day with lukewarm water for 15 days. Results showed an effective improvement in the pain, swelling, dizziness and tenderness caused due to the inflammation of body parts [93].

**Anticancer:** The chemical constituent named Plumbagin present in the PZ plant possesses anticancer property against various cancer cell lines by restricting cell proliferation, blocking cell cycle and inducing apoptosis of APL cell line NB4 cells [94]. The ethanolic extract of the plant diminishes the elevated level of lipid peroxidation and showed effective anticancer property when tested in Ehrlich Ascites Carcinoma in an animal model [95]. Reported studies revealed that the methanolic extract of the chitraka plant shows anticancer and inhibitory property when tested against MCF-7 and HT-29 [96]. Plumbagin restricts apoptosis in human gastric cancer cells because of its capability to suppress the STAT3 and Akt phosphorylation [97].

**Hepatoprotective activity:** The ethanolic extract of chitraka plant was given orally for 6 weeks in the experimental model i.e. streptozotocin induced diabetic rats. The result showed an increase in hepatic hexokinase activity and decreased hepatic glucose-6-phosphatase, alkaline phosphatase (ALP) serum acid phosphatase (ACP) and lactate dehydrogenase (LDH) [98].

**Hypo-cholesterolemic:** Plumbagin isolated from the root extract of chitraka plant was tested against the hyperlipidemic rabbit. It was found that plumbagin reduces serum cholesterol and LDL by 53% to 86% and 61% to 91% respectively. Also, plumbagin inhibits cholesterol and triglyceride accumulation in the liver and aorta [99]. Another study was conducted in hyperlipidemic rabbits where an ethanolic extract of chitraka plant was given in 500mg/kg of dosage. Results showed a significant decrease in serum cholesterol, LDL, cholesterol and triglyceride [100].

**Wound healing:** The methanolic and ethanolic extract isolated from *P. zeylanica* roots showed wound healing property when tested against Wistar albino rats [101]. It was found that chitraka plant possesses wound healing property because of the presence of phytoconstituents like flavonoids, alkaloids, terpenoids, saponins and others [102]. Also, chitraka plant helps in balancing wound healing oxidative stress and accelerate wound healing effect [103].

**Larvicidal:** The hexane and chloroform crude extract isolated from chitraka plant showed significant larvicidal activity against *A. gambiae*. i.e. LC50 6.4 and 6.7 mg/ml respectively [104]. Results showed the larvicidal activity of chitraka plant against the second, third and fourth instar larvae stage of *Aedes aegypti*.

**Anti-ulcer:** Falang et al have identified the anti-ulcer activity of aqueous extract of chitraka plant on aspirin and indomethacin induced acute gastric ulceration in albino rats. Later, the ulcer index, ulcer score and percentage protection of the extract with negative and positive control groups were compared and determined. In aspirin-induced gastric mucosal damage, the extract at dosages 25, 50 and 100 ml/kg showed significant results whereas, in indomethacin-induced ulcer, the extract at 50 and 100 mg/kg dosage exhibited statistically significant [105].

**Effect on Central nervous system:** The hydroalcoholic extract of leaf of chitraka plant showed significant CNS depressant activity with the muscle relaxant property [106].

**Antifungal:** The antifungal property of chitraka plant was tested against the pathogenic yeast, *Candida albicans* and dermatophytes, *Epidermophyton floccosum*, *Microsporum gypseum* and *Trichophyton rubrum*. It was found that the alcoholic extract of chitraka plant showed significant antifungal activity against pathogens and dermatophytes [107].

**Antibacterial:** The aqueous extract (petroleum ether, dichloromethane, methanol, aqueous residue) and alcoholic extract isolated from the root of chitraka plant was investigated for antibacterial activity against *Salmonella gallinarum*, *E. coli*, *Proteus vulgaris*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Salmonella paratyphi* and *Shigella dysenteriae*. The result showed significant antibacterial activity against these bacterial species [108].

**Memory enhancing:** The chloroform extract isolated from roots of chitraka plant was tested against scopolamine-induced amnesia for learning and memory of mice. Results showed significant memory enhancing effect and significantly reversed the amnesia induced by scopolamine at 0.4 mg/kg of dosage [109].

**Anti-obesity:** A clinical study was conducted on obese patients of I.P.G.T & R. Hospital at Jamnagar, Gujarat. The intervention of Haridra powder and *P. zeylanica* was given in capsulated form at 500mg and 1gm/4 times for 45 days with a restricted diet schedule. It was found that the chitraka plant showed an effective result in losing weight of the patients than Haridra powder [110].

**Antiviral:** 80% methanolic extract of chitraka plant was tested against Coxsackie Virus B3 (CVB3), influenza A virus and herpes simplex virus type 1 Kupka (HSV-1) using cytopathic effect (CPE) inhibitory assays in HeLa, MDCK and GMK cells respectively. The methanolic extract inhibited CVB3 production and the antiviral activity of most of the compounds was confirmed by a Plaque reduction assay [111].

Table 4: Reported pharmacological properties of *Plumbago zeylanica*

S. no.	Extract	Invivo / Invitro model	Pharmacological property	References
1.	Alcoholic extract	<i>E.coli, Shigella</i>	Antimicrobial	[83]
2.	Methanolic extract	<i>Bacillus subtilis</i>	Antimicrobial	[84]
3.	Ethanolic extract, chloroform, acetone	<i>Staphylococcus aureus, Salmonella typhi, Pseudomonas aeruginosa, Bacillus subtilis</i>	Antimicrobial	[85]
4.	Crude extract of leaves	<i>E.coli, Bacillus cereus, Staphylococcus aureus, Candida</i>	Antimicrobial	[86]
5.	Ethanolic extract	Diabetic rat	Antidiabetic	[88]
6.	Hydro-alcoholic extract of leaves	Rat model	Anti-inflammatory	[89][90][91]

7.	Ethanollic extract	Animal model	Anti-cancer	[94][95]
8.	Methanollic extract	MCF-7, HT-29	Anti-cancer	[96]
9.	Ethanollic extract	Streptozotocin diabetic rat	Hepatoprotective	[98]
10.	Ethanollic extract	Hyperlipidemic rabbit	Hypocholesterolemia	[99]
11.	Methanollic, ethanollic extract	Wistar albino rat	Wound healing	[101,102,103]
12.	Hexane & chloroform crude extract	<i>A. gambiae</i>	Larvicidal	[104]
13.	Aqueous extract Albino rat	Albino rat	Anti-ulcer	[105]
14.	Hydro-alcohollic extract of leaf	Albino rat	CNS depressant	[106]
15.	Alcohollic extract	<i>Candida albicans, Epidermophyton floccosum, Microspermum gypseum, Trichophyton subrum</i>	Antifungal	[107]
16.	Aqueous extract (petroleum ether, dichloromethane, methanol and aqueous residue) and hydro-alcohollic extract of root	<i>Salmonella gallinarum, E.coli, Proteus vulgaris, Salmonella typhimurium, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella paratyphi, Shigella dysenteriae</i>	Anti-bacterial	[108]
17.	Chloroform extract	Mice	Memory enhancing	[109]
18.	Methanollic extract	CVB3, HSV1, Influenza A virus	Antiviral	[111]

## VII. TOXICITY

The excessive use of chitraka plant results in toxic effects. It causes irritation and intoxicant effect. The toxic effects include burning of tongue, throat, stomach and other body parts. It can also cause nausea, vomiting, diarrhea, dysuria, burning micturition, pulse become weak, wrinkled and cold skin [112]. The root of chitraka plant has been reported to have poisonous effect when administered orally and also cause abortion when applied to ostium uteri [113]. From the reported study it was found that the methanollic extract isolated from the root part of chitraka plant showed limited toxicity and didn't show any overt signs of toxicity in the skin when experimented in rabbit. In pregnancy, the utilization of chitraka plant can irritate pelvic organs and ultimately cause abortion.

## VIII. CONCLUSION

*Plumbago zeylanica* is considered as the most important herbal plant and has a specific place in the herbal medicinal system. The usage of the plant is also popularized in Ayurveda and Unani medicinal systems. Because of the presence of bioactive compounds or phytochemicals, the plant is widely accepted as a rejuvenator (Rasayana). Various pharmacological properties of chitraka plant include anti-malarial, anti-obese, anti-diabetic, anti-microbial, anti-ulcer, anti-

inflammatory, anti-oxidant and anti-cancer activity. This review aim is to provide comprehensive information on chitraka plant and its utilization in the various medicinal system such as traditional, Ayurveda and Unani medicinal system to treat various ailments and disorders. Also, the plant needs more acceptance in the research area to explore its more pharmacological and therapeutic properties which helps in discoveries of new herbal drugs extracted from chitraka plant to improve the health and well-being of humans.

## REFERENCES

- [1] Suffness, M., & Douros, J. (1982). Current status of the NCI plant and animal product program. *Journal of natural Products*, 45(1), 1-14.
- [2] Ganesan, K., & Gani, S. (2013). Ethnomedical and Pharmacological Potentials of *Plumbago zeylanica* L.A. *American Journal of Phytomedicine and Clinical Therapeutics*, 1(3), 313-337.
- [3] Tyagi, R., & Menghani, E. (2014). A Review on *Plumbago zeylanica*: a compelling herb. *Int J Pharma Sci Res*, 5, 119-26.
- [4] Koka Sweta, S., Mamta, P., Vijay, S., Devshree, G., & Darwhekar, G. N. Formulation and Evaluation of Topical Antifungal Herbal Gels Containing Hydroalcoholic Extract of *Catharanthus roseus* and *Aloe vera*.

- [5] Chaudhari, S. S., & Chaudhari, G. S. (2015). A review on plumbago zeylanica linn.-A divine medicinal plant. *International Journal of Pharmaceutical Sciences Review and Research*, 30(2), 119-127.
- [6] Kishore, N., Mishra, B. B., Tiwari, V. K., & Tripathi, V. (2012). An account of phytochemicals from *Plumbago zeylanica* (Family: Plumbaginaceae): A natural gift to human being. *Chronicles of Young Scientists*, 3(3).
- [7] Record, P. (2012). *Prota 11 (1): Medicinal plants/Plantemédicinales I. Record display*. Consultado 23/01/2012. <http://database.prota.org/PROTAhtml/Plantago%20lanceolata>.
- [8] Abera, B., Negash, L., & Kumlehn, J. (2008). Reproductive biology in the medicinal plant, *Plumbago zeylanica* L. *African Journal of Biotechnology*, 7(19).
- [9] Aditi, G. (1999). Medicinal plants used in traditional medicine in Jimma zone, South West Ethiopia. *Pharm. Biol*, 37, 321-323.
- [10] Vishnukanta, R. A., & Rana, A. C. (2010). Evaluation of anticonvulsant activity of *Plumbago zeylanica* Linn leaf extract. *Asian Journal of Pharmaceutical and Clinical Research*, 3(1), 76-78.
- [11] Lubaina, A. S., Nair, G. M., & Murugan, K. (2011). Shoot multiplication and direct organogenesis of an important medicinal plant *Plumbago zeylanica* L.(Plumbaginaceae). *Journal of Research in Biology*, 6, 424-428.
- [12] Vineet, M., Sharma, S. K., Deepak, K., Meenu, K., & Kusum, T. (2010). A comparative study of analgesic activity of *Plumbago zeylanica* Linn. callus and root extracts in experimental mice. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 1(4), 830-836.
- [13] Dalziel, J. M. (1937). The useful plants of west tropical Africa. *The useful plants of West Tropical Africa*.
- [14] Jiangsu, S. (1979). New Medical College, Zhonyao Dictionary (Encyclopedia of Chinese Materia). *Scientific and Technological Press, Shanghai*, 711-712.
- [15] Abebe, D., & Ayehu, A. (1993). Medicinal plants and enigmatic health practices of Northern Ethiopia.
- [16] Didry, N., Dubreuil, L., & Pinkas, M. (1994). Activity of anthraquinonic and naphthoquinonic compounds on oral bacteria. *Die Pharmazie*, 49(9), 681-683.
- [17] Lin, L. C., Yang, L. L., & Chou, C. J. (2003). Cytotoxic naphthoquinones and plumbagic acid glucosides from *Plumbago zeylanica*. *Phytochemistry*, 62(4), 619-622.
- [18] Raman, M. S., Anwar, M. N., & Chowdhury, A. Z. M. S. (1999). Antibacterial activity of secondary metabolites from *Holarrhena antidysenterica* stem bark. *Bangladesh J Microbiol*, 16(2), 101-105.
- [19] Chiu NY, Chang KH.( 1995) The Illustrated Medicinal Plants of Taiwan, Vol. 2. SMC Publishing Inc., Taipei, Taiwan.; 2:285.
- [20] KR K. Basu BD (1987). Indian medicinal plants. Vol. II. Dehradun: International Book Distributors:1429.
- [21] Dai, Y., Hou, L. F., Chan, Y. P., Cheng, L., & But, P. P. H. (2004). Inhibition of immediate allergic reactions by ethanol extract from *Plumbago zeylanica* stems. *Biological and Pharmaceutical Bulletin*, 27(3), 429-432.
- [22] Kubo, I., Uchida, M., & Klocke, J. A. (1983). An insect ecdysis inhibitor from the African medicinal plant, *Plumbago capensis* (Plumbaginaceae); a naturally occurring chitin synthetase inhibitor. *Agricultural and Biological Chemistry*, 47(4), 911-913.
- [23] Kanchana, N., & Sadiq, A. M. (2011). Hepatoprotective effect of *Plumbago zeylanica* on paracetamol induced liver toxicity in rats. *Int J Pharm Pharm Sci*, 3(1), 151-154.
- [24] Olagunju, J. A., Jobi, A. A., & Oyedapo, O. O. (1999). An investigation into the biochemical basis of the observed hyperglycaemia in rats treated with ethanol root extract of *Plumbago zeylanica*. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*, 13(4), 346-348.
- [25] Kavimani, S., Ilango, R., Madheswaran, M., Jayakar, B., Gupta, M., & Majumdar, U. K. (1996). Antitumour activity of *Plumbago zeylanica* against Dalton's Ascitic lymphoma. *Indian journal of pharmaceutical sciences*, 58(5), 194.
- [26] Krishnaswamy, M., & Purushothaman, K. K. (1980). Plumbagin: a study of its anticancer, antibacterial and antifungal properties. *Indian journal of experimental biology*, 18(8), 876-877.
- [27] Vishnukanta, R. A., & Rana, A. C. (2010). Evaluation of anticonvulsant activity of *Plumbago zeylanica* Linn leaf extract. *Asian Journal of Pharmaceutical and Clinical Research*, 3(1), 76-78.
- [28] Unander, D. W., Webster, G. L., & Blumberg, B. S. (1995). Usage and bioassays in *Phyllanthus* (Euphorbiaceae). IV. Clustering of antiviral uses and other effects. *Journal of Ethnopharmacology*, 45(1), 1-18.
- [29] Satyavati, G. V., Raina, M. K., & Sharma, M. (1987). *Medicinal plants of India* (Vol. 2). Indian Council of Medical Research.
- [30] Kulkarni, R., Girish, K. J., & Kumar, A. (2012). Nootropic herbs (Medhya Rasayana) in Ayurveda: an update. *Pharmacognosy reviews*, 6(12), 147.
- [31] Sharma, P. C., Yelne, M. B., Dennis, T. J., Joshi, A., & Billore, K. V. (2000). Database on medicinal plants used in Ayurveda.
- [32] Mukesh, S., Kusharaga, N., Shiv, I., Gaurav, K., Gotmi, S., & DK, T. (2011). Ethnomedicinal, traditional and pharmacological aspects of *Plumbago zeylanica*. *Linn. Pharmacologyonline*, 3, 684-700.
- [33] Dev, S. (2006). *selection of prime ayurvedic plant drugs*. Anamaya Publishers.
- [34] Sastri, B. N. (1950). The Wealth of India. A Dictionary of Indian Raw Materials and Industrial

Products. Raw Materials. *The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials.*

[35] Chaudhari, S. S., & Chaudhari, G. S. (2015). A review on plumbago zeylanica linn.-A divine medicinal plant. *International Journal of Pharmaceutical Sciences Review and Research*, 30(2), 119-127.

[36] Vasudeva, N., Yadav, N., & Sharma, S. K. (2012). Natural products: a safest approach for obesity. *Chinese journal of integrative medicine*, 18(6), 473-480.

[37] Chetty, K. M. (2006). Pharmaceutical studies and therapeutic uses of Plumbago zeylanica L. roots (Chitraka, Chitramulam). *Ethnobotanical Leaflets*, 2006(1), 33.

[38] Ming, Y., Wang, J., Yang, J., & Liu, W. (2011). Chemical Constituents of Plumbago Zeylanica L. In *Advanced Materials Research* (Vol. 308, pp. 1662-1664). Trans Tech Publications Ltd.

[39] Lubaina, A. S., Nair, G. M., & Murugan, K. (2011). Shoot multiplication and direct organogenesis of an important medicinal plant Plumbago zeylanica L.(Plumbaginaceae). *Journal of Research in Biology*, 6, 424-428.

[40] Kumar, R., Kumar, S., Patra, A., & Jayalakshmi, S. (2009). Hepatoprotective activity of aerial parts of Plumbago zeylanica linn against carbon tetrachloride-induced hepatotoxicity in rats. *Int J Pharmacy Pharmaceut Sci*, 1(1), 171-175.

[41] Chetty, K. M. (2006). Pharmaceutical studies and therapeutic uses of Plumbago zeylanica L. roots (Chitraka, Chitramulam). *Ethnobotanical Leaflets*, 2006(1), 33.

[42] Ming, Y., Wang, J., Yang, J., & Liu, W. (2011). Chemical Constituents of Plumbago Zeylanica L. In *Advanced Materials Research* (Vol. 308, pp. 1662-1664). Trans Tech Publications Ltd.

[43] van der Vijver, L. M., & Lötter, A. P. (1971). The constituents in the roots of Plumbago auriculata Lam. and Plumbago zeylanica L. responsible for antibacterial activity. *Planta medica*, 20(03), 8-13.

[44] Sankaram, A. V., Srinivasarao, A., & Sidhu, G. S. (1976). Chitranone--a new binaphthaquinone from Plumbago zeylanica. *Phytochemistry*.

[45] Kodithala, K., Hopfinger, A. J., Thompson, E. D., & Robinson, M. K. (2002). Prediction of skin irritation from organic chemicals using membrane-interaction QSAR analysis. *Toxicological Sciences*, 66(2), 336-346.

[46] Kulkarni, A., Hopfinger, A. J., Osborne, R., Bruner, L. H., & Thompson, E. D. (2001). Prediction of eye irritation from organic chemicals using membrane-interaction QSAR analysis. *Toxicological Sciences*, 59(2), 335-345.

[47] Zhang, Q. R., Mei, Z. N., Yang, G. Z., & Xiao, Y. X. (2007). Chemical constituents from aerial parts of Plumbago zeylanica Linn. *Zhong yao cai= Zhongyaocai= Journal of Chinese medicinal materials*, 30(5), 558-560.

[48] Nguyen, A. T., Malonne, H., Duez, P., Vanhaelen-Fastre, R., Vanhaelen, M., & Fontaine, J. (2004). Cytotoxic constituents from Plumbago zeylanica. *Fitoterapia*, 75(5), 500-504.

[49] Dinda, B., Hajra, A. K., & Das, S. K. (1998). Chemical Constituents of Plumbago indica Roots. *ChemInform*, 29(48), no-no.

[50] Gunaherath, G. K. B., Gunatilaka, A. L., Sultanbawa, M. U. S., & Balasubramaniam, S. (1983). 1, 2 (3)-Tetrahydro-3, 3 -biplumbagin: A naphthalenone and other constituents from Plumbago zeylanica. *Phytochemistry*, 22(5), 1245-1247.

[51] Sankaram, A. V., Srinivasarao, A., & Sidhu, G. S. (1976). Chitranone--a new binaphthaquinone from Plumbago zeylanica. *Phytochemistry*.

[52] Tezuka, M., Takahashi, C., Kuroyanagi, M., Satake, M., Yoshihira, K., & Natori, S. (1973). New naphthoquinones from Diospyros. *Phytochemistry*, 12(1), 175-183.

[53] Murray, R. D., & Zeghdi, S. (1989). Synthesis of the natural coumarins, murraol (CM-c2), trans-dehydroosthol and swietenocoumarin G. *Phytochemistry*, 28(1), 227-230.

[54] Ganesan, K., & Gani, S. (2013). Ethnomedical and Pharmacological Potentials of Plumbago zeylanica LA. *American Journal of Phytomedicine and Clinical Therapeutics*, 1(3), 313-337.

[55] Nayar, M. N. S., & Bhan, M. K. (1972). Coumarins and other constituents of Hesperethusa crenulata. *Phytochemistry*, 11(11), 3331-3333.

[56] WU, T., KUOH, C., & FURUKAWA, H. (1983). Acridone Alkaloids. VI. The Constituents of Citrus depressa. Isolation and Structure Elucidation of New Acridone Alkaloids from Citrus genus. *Chemical and Pharmaceutical Bulletin*, 31(3), 895-900.

[57] Ito, C., MATSUOKA, M., OKA, T., JU-ICHI, M., NIWA, M., OMURA, M., & FURUKAWA, H. (1990). New Binary Coumarins from Citrus Plants. *Chemical and pharmaceutical bulletin*, 38(5), 1230-1232.

[58] Lin, L. C., & Chou, C. J. (2003). Meroterpenes and C-glucosylflavonoids from the aerial parts of Plumbago zeylanica. *The Chinese Pharmaceutical Journal*, 55(1), 77-81.

[59] Pant, M., Lal, A., Rana, S., & Rani, A. (2012). Plumbago zeylanica L.: a mini review. *International Journal of Pharmaceutical Applications*, 3(3), 399-405.

[60] Chaudhari, S. S., & Chaudhari, G. S. (2015). A review on plumbago zeylanica linn.-A divine medicinal plant. *International Journal of Pharmaceutical Sciences Review and Research*, 30(2), 119-127.

[61] Vishnukanta, R. A., & Rana, A. C. (2010). Evaluation of anticonvulsant activity of Plumbago zeylanica Linn leaf extract. *Asian Journal of Pharmaceutical and Clinical Research*, 3(1), 76-78.

[62] Chatterjee, A., & Pakrashi, S. C. (2003). Treaties on Indian medicinal plants: national institute of science communication and information resources. *New Delhi, India*, 3, 146-147.

- [63] Dev, S. (2006). *selection of prime ayurvedic plant drugs*. Anamaya Publishers.
- [64] Bhutya, R. K. (2011). *Ayurvedic Medicinal Plants of India (Vol. 1)* (Vol. 1). Scientific Publishers.
- [65] Gogte VM. Ayurvedic Pharmacology and therapeutic uses of Medicinal plants (Dravyagunavignyan), translation by the academic team of Bharatiya Vidya Bhavan's SPARC. Chaukhambha Publication, New Delhi. 2009:370-2. Prajapati ND, Purohit SS, Sharma AK, Kumar T. A Handbook of Medicinal Plants (Agrobios, Jodhpur).
- [66] Olagunju, J. A., Fagbohunka, B. S., Oyedapo, O. O., & Abdul, A. I. A. (2006). Effects of an ethanolic root extract of *Plumbago zeylanica* Linn. on some serum parameters of the rats. *RPMP-Drug Dev. Mol*, 11, 268-276.
- [67] Chiu NY, Chang KH (1995). The Illustrated Medicinal Plants of Taiwan, Vol. 2. SMC Publishing Inc., Taipei, Taiwan.;2:285.
- [68] Sharma, N., & Kaushik, P. (2014). Medicinal, biological and pharmacological aspects of *Plumbago zeylanica* (Linn.). *Journal of Pharmacognosy and Phytochemistry*, 3(4), 117-120.
- [69] Jiangsu, S. (1979). New Medical College, Zhonyao Dictionary (Encyclopedia of Chinese Materia). *Scientific and Technological Press, Shanghai*, 711-712.
- [70] Simonsen, H. T., Nordskjold, J. B., Smitt, U. W., Nyman, U., Palpu, P., Joshi, P., & Varughese, G. (2001). In vitro screening of Indian medicinal plants for antiplasmodial activity. *Journal of Ethnopharmacology*, 74(2), 195-204.
- [71] Uniyal, M. R., & Joshi, G. C. (1993). Historical view of the basic principles of the identification of controversial drugs, problems and suggestions. *Sachitra Ayurved*, 45(7), 531-536.
- [72] Saraswathy, A. (2001). Adulterants and substitutes in Ayurveda. *Sachitra Ayurved*, 54(1), 63-66.
- [73] Gupta, A. K. (2003). Quality standards of Indian medicinal plants. Volume 1. *Quality standards of Indian medicinal plants. Volume 1*.
- [74] Song, J., Yao, H., Li, Y., Li, X., Lin, Y., Liu, C., ... & Chen, S. (2009). Authentication of the family Polygonaceae in Chinese pharmacopoeia by DNA barcoding technique. *Journal of Ethnopharmacology*, 124(3), 434-439.
- [75] Newmaster, S. G., Grguric, M., Shanmughanandhan, D., Ramalingam, S., & Ragupathy, S. (2013). DNA barcoding detects contamination and substitution in North American herbal products. *BMC medicine*, 11(1), 1-13.
- [76] Gilbert, N. (2011). Regulations: Herbal medicine rule book. *Nature*, 480(7378), S98-S99.
- [77] Mitra, S. K., & Kannan, R. (2007). A note on unintentional adulterations in Ayurvedic herbs. *Ethnobotanical Leaflets*, 2007(1), 3.
- [78] Poornima, B. (2010). Adulteration and substitution in herbal drugs a critical analysis. *IJRAP*, 1(1), 8-12.
- [79] Roy, A., Mallick, A., & Kaur, A. (2013). Adulteration and substitution in Indian medicinal plants. *IJPRBS*, 2, 208-18.
- [80] Goswami, A., Barooah, P. K., & Sandhu, J. S. (2002). Prospect of herbal drugs in the age of globalization-Indian scenario. *J Scientific Industrial Research*, 61(6), 423-431.
- [81] Ahmad, I., & Aqil, F. (2007). In vitro efficacy of bioactive extracts of 15 medicinal plants against ESβL-producing multidrug-resistant enteric bacteria. *Microbiological Research*, 162(3), 264-275.
- [82] Devi, C. K., & Krishna, D. G. (2012). Pharmacognostic, phytochemical and biological study of *Plumbago zeylanica*. *International Journal of Natural Products Research*, 1(2), 21-23.
- [83] Banik, B., Sarkar, P., Sultana, F., Saikia, M., & Dey, A. (2014). In-vitro antimicrobial screening with phytochemical study of *Plumbago zeylanica* L. collected from two regions of Eastern Himalayas-A comparative study. *Int J Phytopharm*.
- [84] Shweta, S., & Dubey, S. (2015). Antimicrobial activity of leaves extract of *Plumbago zeylanica* plant against known drugs. *IJRBS*, 3(6), 1-6.
- [85] Zarmouh, M. M., Subramaniam, K., Viswanathan, S., & Kumar, P. G. (2010). Cause and effect of *Plumbago zeylanica* root extract on blood glucose and hepatic enzymes in experimental diabetic rats. *African Journal of Microbiology Research*, 4(24), 2674-2677.
- [86] Sunil, C., Duraipandiyam, V., Agastian, P., & Ignacimuthu, S. (2012). Antidiabetic effect of plumbagin isolated from *Plumbago zeylanica* L. root and its effect on GLUT4 translocation in streptozotocin-induced diabetic rats. *Food and chemical toxicology*, 50(12), 4356-4363.
- [87] Sheeja, E., Joshi, S. B., & Jain, D. C. (2010). Bioassay-guided isolation of anti-inflammatory and antinociceptive compound from *Plumbago zeylanica* leaf. *Pharmaceutical biology*, 48(4), 381-387.
- [88] Dang, G. K., Parekar, R. R., Kamat, S. K., Scindia, A. M., & Rege, N. N. (2011). Antiinflammatory activity of *Phyllanthus emblica*, *Plumbago zeylanica* and *Cyperus rotundus* in acute models of inflammation. *Phytotherapy Research*, 25(6), 904-908.
- [89] Checker, R., Sharma, D., Sandur, S. K., Khanam, S., & Poduval, T. B. (2009). Anti-inflammatory effects of plumbagin are mediated by inhibition of NF-kappaB activation in lymphocytes. *International Immunopharmacology*, 9(7-8), 949-958.
- [90] Arunachalam, K. D., Velmurugan, P., & Raja, R. B. (2010). Anti-inflammatory and cytotoxic effects of extract from *Plumbago zeylanica*. *African journal of microbiology research*, 4(12), 1239-1245.
- [91] Napalchyal, K. S., Shinde, S., Singh, J. P., & Mishra, D. S. (2013). Clinical evaluation of Chitrakadi Churna combined with the Kshar Vasti in the Management of Amavata (Rheumatoid Arthritis). *Journal of Ayurveda*, 7(3), 73-80.

- [92] Zhao, Y. L., & Lu, D. P. (2006). Effects of plumbagin on the human acute promyelocytic leukemia cells in vitro. *Zhongguo shi yan xue ye xue za zhi*, 14(2), 208-211.
- [93] Hiradeve, S., Danao, K., Kharabe, V., & Mendhe, B. (2010). Evaluation of anticancer activity of Plumbago zeylanica Linn leaf extract. *Int J Biomed Res*, 1(2), 1-9.
- [94] Aditya, V. S., Kumar, N. L., & Mokkaapati, A. L. (2013). In vitro anti-cancer activities of few plant extracts against MCF-7 and HT-29 cell lines. *Int J Pharma Sci*, 3, 185-8.
- [95] Li, J., Li, J., Cai, G., Shen, L., & Lu, F. (2017). Proapoptotic and Growth-inhibitory Effects of Plumbagin on Human Gastric Cancer Cells Via Suppression of Signal Transducer and Activator of Transcription 3 and Protein Kinase B. *Alternative Therapies in Health & Medicine*, 23(7).
- [96] Zarmouh, M. M., Subramaniam, K., Viswanathan, S., & Kumar, P. G. (2010). Cause and effect of Plumbago zeylanica root extract on blood glucose and hepatic enzymes in experimental diabetic rats. *African Journal of Microbiology Research*, 4(24), 2674-2677.
- [97] Sharma, I. N. D. U., Gusain, D. E. E. P. A. L. I., & Dixit, V. P. (1991). Hypolipidaemic and antiatherosclerotic effects of plumbagin in rabbits. *Indian J Physiol Pharmacol*, 35(1), 10-14.
- [98] Alpana, R. (1996). Effect of Plumbago zeylanica in hyperlipidaemic rabbits and its modification by vitamin E. *Indian Journal of pharmacology*, 28(3), 161.
- [99] Kodati, D. R., Burra, S., & Kumar, G. P. (2011). Evaluation of wound healing activity of methanolic root extract of Plumbago zeylanica L. in wistar albino rats. *Asian Journal of Plant Science and Research*, 1(2), 26-34.
- [100] Jyothi, V. A., & Fathima, B. (2013). Phytochemical evaluation & pharmacological screening of wound healing & antioxidant activity of Plumbago zeylanica. *International Journal of Pharmacy and Technology*, 5(3), 5879-5891.
- [101] Honnegowda, T. M., Kumar, P., Udupa, E. P., Sharan, A., Singh, R., Prasad, H. K., & Rao, P. (2015). Effects of limited access dressing in chronic wounds: A biochemical and histological study. *Indian journal of plastic surgery: official publication of the Association of Plastic Surgeons of India*, 48(1), 22.
- [102] Maniafu, B. M., Wilber, L., Ndiege, I. O., Wanjala, C. C., & Akenga, T. A. (2009). Larvicidal activity of extracts from three Plumbago spp against *Anopheles gambiae*. *Memórias do Instituto Oswaldo Cruz*, 104(6), 813-817.
- [103] Falang, K. D., Uguru, M. O., Wannang, N. N., Azi, H. H., & Chiamaka, N. (2012). Anti-ulcer activity of Plumbago Zeylanica Linn. root extract. *J Nat Prod Plant Resour*, 2(5), 563-567.
- [104] Roy, A., & Bharadvaja, N. (2017). A review on pharmaceutically important medical plant: Plumbago zeylanica. *Journal of Ayurvedic and Herbal Medicine*, 3(4), 225-228.
- [105] Mehmood, Z., Ahmad, I., Mohammad, F., & Ahmad, S. (1999). Indian medicinal plants: a potential source for anticandidal drugs. *Pharmaceutical Biology*, 37(3), 237-242.
- [106] Abdul, K. M., & Ramchender, R. P. (1995). Modulatory effect of plumbagin (5-hydroxy-2-methyl-1, 4-naphthoquinone) on macrophage functions in BALB/c mice. I. Potentiation of macrophage bactericidal activity. *Immunopharmacology*, 30(3), 231-236.
- [107] Jain, P., Sharma, H. P., Basri, F., Baraik, B., Kumari, S., & Pathak, C. (2014). Pharmacological profiles of ethno-medicinal plant: Plumbago zeylanica L.- A review. *Int J Pharm Sci Rev Res*, 24(1), 157-63.
- [108] Kotecha, M., & Rao, K. S. (2007). Clinical evaluation of haridra & chitrak in the management of medoroga (obesity). *Journal of ayurveda*, 1, 226-28.
- [109] Gebre-Mariam, T., Neubert, R., Schmidt, P. C., Wutzler, P., & Schmidtke, M. (2006). Antiviral activities of some Ethiopian medicinal plants used for the treatment of dermatological disorders. *Journal of Ethnopharmacology*, 104(1-2), 182-187.
- [110] Gogte VM. Ayurvedic Pharmacology and therapeutic uses of Medicinal plants (Dravyagunavignyan), (2009) translation by the academic team of Bharatiya Vidya Bhavan's SPARC. Chaukhambha Publication, New Delhi.:370-2.
- [111] AK, A. C., KC, S., & AK, A. K. (1982). Antifertility activity of Plumbago zeylanica Linn. root.
- [112] Edwin, S., Joshi, S. B., & Jain, D. C. (2009). Antifertility activity of leaves of Plumbago zeylanica Linn. in female albino rats. *The European Journal of Contraception & Reproductive Health Care*, 14(3), 233-239.
- [113] Dai, Y., Hou, L. F., Chan, Y. P., Cheng, L., & But, P. P. H. (2004). Inhibition of immediate allergic reactions by ethanol extract from Plumbago zeylanica stems. *Biological and Pharmaceutical Bulletin*, 27(3), 429-432.