Review Article

Medicinal importance of *Ephedra gerardiana* in ayurveda and modern sciences: A review

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Abstract

Ephedra gerardiana (Ma-Huang) is a significant medicinal herb that belongs to the family *Ephedraceae*. There are about 73 species of *Ephedra* genus that are accepted as of June 2021. This plant is mostly found in dry rocks and sandy soil as its growth requires high and dry mountain deserts. The different parts of the plant such as branches, root, stem are used medicinally in various formulations practices. For example, the dried parts of the plant are used in various medicinal systems such as ayurvedic, Unani, Siddha and Chinese to cure variety of diseases such as asthma, nasal congestion, hay fever, inflammation or swelling, urinary disorders, cardiac disorders, cough, chills and cold. In Chinese medicinal system, the *E. gerardiana* plant is used for 5000 years to cure fever, asthma and nasal congestion. The active constituents of the plant i.e. ephedrine, nor-ephedrine and pseudoephedrine possess various therapeutic and pharmacological properties. These properties include anti-inflammatory, anti-arthritic, anti-asthmatic, antimicrobial, antidiabetic, cardiovascular, diuretic and CNS stimulant activities. Ephedrine and nor-ephedrine alkaloid constituents of the *E. gerardiana* plant are used to completely eradicate the symptoms of hay fever and allergy. Also, the catechin and epicatechin constituents of the plant are used in various formulations of weight loss drinks and pills. Besides this, the pulp part of the plant is used as a source of food for birds and rodents and is also used in jam preparation. In this review article, attempts have been made to briefly describe the ayurvedic and folklore uses of the plant along with the general description of the plant.

***Keywords**:* Somlata, Pharmacological properties, Ayurveda, Rasapanchak, Anti-inflammatory.

Introduction

Medicinal plants contain numerous phytochemical constituents that are associated with different therapeutic properties (Nair et al., 2005; Ghorbani, 2005). Due to this, these medicinal plants are used in various herbal drug formulations (Chukwuma et al, 2015; Lifongo et al., 2014). These drugs possess various advantages when compared to allopathic drugs such as easy availability, fewer side effects and low cost (Yadav and Aggarwal, 2011; Simmler et al., 2018; Ichim, 2010). In India, medicinal plants are used since ancient times to cure various ailments and disorders (Thakur et al., 2021). More than 45000 species of plants are found in India, thus called as Botanical Garden of the World (Sukumaran and Raj, 2010; Abd EI-Ghani, 2016). The medicinal systems such as folk, ayurvedic, Siddha, Unani and Chinese medicinal systems use these herbal plants to treat various diseases and ailments (Verma and Singh, 2008). Besides this, most of the allopathic or modern drugs are prepared from these herbal plants (Yorek et al., 2008). Nearly, half of the modern drugs out of 104 global drugs have their origin from these herbal plants from the last 37 years (Gen, 1986). These medicinal plants are a rich source of bioactive components and secondary metabolites such as alkaloids, flavonoids, triterpenes, saponins, phenolics and others(Kumari et al., 2021). These compounds have particular suitable physiological action in the human body as a result of which the herbal products derived from medicinal plants carry fewer side effects (Kumari et al., 2021). One such medicinal plant is *Ephedra gerardiana* (figure 1) which is of great medicinal importance. The plant is commonly called somlata (Ma-huang) and belongs to the *Ephedraceae* family. It is considered the oldest herb to mankind that is used for 1000 years and originally belongs to

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Figure 1. *Ephedra gerardiana*

Table 1. Vernacular names of *E. gerardiana*

Sanskrit	Somlata
English	Ephedra, jointfir
Hindi	Tootagantha
Tamang	Tseh
Pashto	Uman
Tibetan	Amsania, Budagur, Chefrat, Khanda Ma Houng
Chinese	Ma-huang
Ladakh	Somlata plant, thayon

Table 2. Taxonomical Classification

Taxonomical Rank	Taxon
Kingdom	Plantae
Clade	Tracheophytes
Division	Gnetophyta
Class	Gnetopsida
Order	Ephedrales
Family	*Ephedraceae*
Genus	*Ephedra*
Species	*E. gerardiana*
Common name	Somlata

the traditional Chinese medicine system. The plant is mainly grown in drylands and sandy deserts. It can survive in drought conditions as well. This plant is used in the Indian medicinal system since ancient times. Also, Ephedra was well known during the time of the Roman Empire. Traditionally, the plant is used in the various medicinal system to treat ailments such as cough, cold, chronic fevers, respiratory disorders, urinary problems, nasal congestion and others (Zhu, 1998). In Ayurvedic medicinal system, the plant is used to treat anti-inflammatory diseases like edema or swelling, cough, fever, asthma, heart diseases, urinary disorders and many more. Also, the plant is associated with anti-arthritic and anti-inflammatory properties. Some ayurvedic formulations containing soma as a main ingredient include Bronkasava liquid (helps in curing respiratory diosrders), Asthmin capsule (asthma, bronchitis, cough) and Branchozen syrup (cure dry and productive cough). The phytochemical constituents of the plant are associated with various therapeutic and pharmacological properties such as antimicrobial, antidiabetic, anti-asthmatic, weight loss effects, CNS stimulant, cardiovascular and diuretic (Gaur and Sharma, 2011). The salts of ephedra are used in the form of nasal sprays to cure swelling and congestion. Also, ephedrine is used in the form of a subcutaneous injection to prevent hypotension. Besides this, due to the overexploitation of *E. gerardiana* plant for medicinal purposes, overgrazing, export and over-harvesting, it comes under the endangered species (Akbar et al., 2011). The vernacular names and taxonomical classification of the plant are shown in table 1 and 2 respectively.

Botanical description

The genus Ephedra consists of 42 species. One of the species of the Ephedra genus is *Ephedra gerardiana* which is an erect, perennial shrub, dioecious, evergreen, profusely branched, xerophytic plant with densely clustered slender erect joined branches arise from the woody base. These branches are curved, dark green, arising in whorls and can grow up to 3700-5600m above sea level (Akbar et al., 2011). It is mainly found on dry rocks and sandy deserts (Friedman, 1996). The plant can survive in parched conditions and can also grow in soil containing high salt content (Rungsung et al., 1997). The height of the plant reaches up to one-half to 6 feet tall. The width of the basal stem ranges from 3 to 5 inches with thick bark. Nodes and internodes are present in the ascending branched stem which constitutes the drug. The plant contains very few stipulate leaves consists of teeth-like projections called stalks that form a sheath around the nodes. The flowers directly germinate from terminal axillary stalks. The fruits of the plant are sweet, edible, red, round, single-seeded, 1-3 mm in width which matures in autumn (Morton, 1997). The stem of the plant is cylindrical, greenish-yellow astringent, slightly aromatic and bitter (Rinchen et al., 2021).

Geographical distribution

E. gerardiana is mainly found in the dry alpine and temperate Himalayan regions at an altitude of 3900 m above sea level. The plant is grown world-widely in countries like China, Baluchistan, Pakistan, Europe, South America, Temperate Asia, Afghanistan and Bhutan. In India, the plant is distributed from Kashmir to Sikkim (altitude range 2100-4800 m above sea level), Lahaul-Spiti, Chamba, Kinnaur, Uttarakhand, Himachal Pradesh, Jammu and Ladakh (Abourashed et al.,

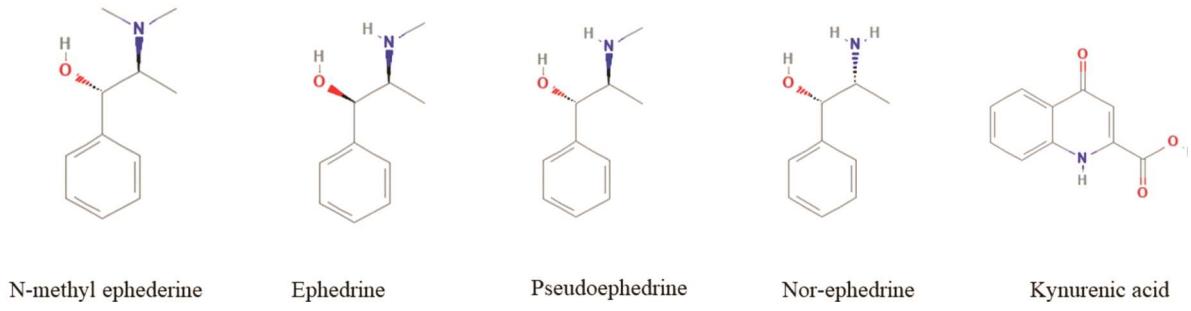

Figure 2. Structures of some major phytochemicals present in Ephedra geradiana

2003). China was the main producer of *E. gerardiana* but now India and Pakistan have also become the main producer of *E. gerardiana* plant (Chaudhari, 1957).

Phytochemical constituents of *E. gerardiana*

The chemical constituents present in the aerial parts of Ephedra species are alkaloids. The alkaloids are present in 0.5% to 2.5% while it is present in 0.02-3.4% in aerial parts containing six other alkaloids which are mostly present in the internodes (Soni et al., 2004). The main active constituent present is (-)-Ephedrine (EPH) which constitutes 30-90% of the total alkaloids. It was the first alkaloid extracted from the plant in 1887 by the Japanese pharmacist Nagai. The other alkaloids present are (+)-pseudoephedrine (PSE) which is a diastereomer of (-)-EPH (extracted in 1889 by Ladenburg and Oelschlagel), ephedroxane, oxazolidone derivative of (-) -EPH, l- (-) ephedrine, methylephedrine (Konno et al., 1979). Ephedroxane alkaloid was found to be associated with anti-inflammatory activity (Manandhar, 1980). Also, the plant is a good source of catechins and (-) epicatechin that helps in weight loss. The other components present are polyphenols, quercetin, gallic acid, macrocyclic spermine alkaloids, kynurenic acid derivative, flavones, tannins, anoproline amino acid, flavonols, methanoproline amino acid, ephedradinnes A-D, carboxylic acid, volatile terpenes and herbacetin. Gallic acid is known for anti-cancer and anti-inflammatory activity, ephedrannine A is known for hypotensive activity while quercetin is known for antioxidant activity (Tai, 2003). The other active isomers extracted from the plant include (-) N-methylephedrine, (-) norephedrine, (+) N-methylpseudoephedrine and (_) nor pseudoephedrine that were found in the 1920s. Pseudoephedrine is reported as the second major isomer while the other alkaloids are found in very few amounts (Konno et al., 1979). The structures of some major phytochemicals are shown in figure 2.

Traditional and modern view

a) Ayurvedic View: *E. gerardiana* plant is used in Ayurveda and other medicinal systems such as Unani, Siddha and Chinese medicinal systems since ancient times to treat various ailments. In Ayurveda, the plant is used to treat cough, headache, edema, headaches, allergies, chills, flu and nasal congestions. The plant alleviates the Kapha (Earth and Water component) and Vata (Air) component. The dried parts of the plant are used in tea which helps in elevating blood pressure, for diuretic and also helpful in the constriction of blood vessels of blood. It is also used to treat hay fevers asthma and other respiratory disorders by the people of Nepal (Baker, 2010). The plant extracts of the plant are also used in the formulation of psychotic medicines with other plants such as mushrooms (Morton, 1977). Also, the oral intake of the plant extract helps in treating angioneurotic edema, nocturnal enuresis, urticarial, epilepsy, nasal congestion and myasthenia gravis. The oral intake of the pseudoephedrine constituent showed a positive effect as a nasal decongestant (Chaturvedi and Dass, 2011). The rasapanchak (properties) of the plant is shown in table 3

Table 3. Rasapanchak (properties) of *E. gerardiana*

Sanskrit / English	Sanskrit / English
Veerya / Potency	Ushna / Hot
Vipak / Metabolic property	Katu / Bitter
Guna / Physical property	Laghu / Light, Ruksha / Dry
Rasa / Taste	Kshaya / astringent

Actions and Properties (Sharma, 1956) Kaphavatashamak: It alleviates the Kapha and Vata components.

Shothahara: It is used as an anti-inflammatory agent which helps in reducing swelling or inflammation.

Vedanasthapan: It is used as an analgesic agent.

Naadimandal: It stimulates the pulse chamber.

Hridorabalya: It stimulates heart functions and strengthens the heart muscle.

Shwasana: It stimulates the respiratory system.

Mutrala: It acts as a diuretic agent.

Garbhashayesankochak: It helps in uterine contraction.

Jwarghna: It acts as an antipyretic agent.

Vatikmanovikar: It helps in treating psychosomatic disorders.

b) Folk Uses: *E. gerardiana* plant is used in folklore to treat several diseases. It is the oldest medicinal plant known in the Chinese medicinal system. In China, the plant is used traditionally to treat coughs, colds, allergies, influenza, bronchial asthma, chills, headaches, fever, flu, edema, nasal congestion and arthralgia (Musselman, 1996). The plant is also used to cure fever, low BP, headache, hives and lack of perspiration (Gonzalez-Juarez et al., 2020). The stem part of *E. gerardiana* is used to treat diaphoretic indications while the root or rhizome part of the plant is associated with antiperspirant property (Leung, 1990). In India, somlata plant is known from the Vedic eras where it was used as a substitute for the psychoactive plant with a lost identity. The formulations of *E. gerardiana* are used as a mood enhancer and CNS stimulant in the West (Hussain et al., 2006). The fruit pulp of the plant is found to be the richest source of amino acids and is used in the preparation of jams (Calzada et al., 2020). In Mexico, Ephedra species are used to cure infectious and chronic – degenerative diseases (Salazar JR et al., 2020) Gurmeet and Stobgais, 2016). In the US, *E. gerardiana* is a famous herb and is used for weight loss and performance enhancement. The local practitioners or ethnic people of Ladakh use *E. gerardiana* plant to treat cough, sweating, chronic fever, tumor, breathing disorders and urinary disorders (Bhattacharyya, 1991). The twigs of the plant are used as a toothbrush in Ladakh (Navchoo and Buth, 1992). In cold deserts, the whole plant is used for fuel, fruits are used for eating and aerial parts of the plants are used for religious purposes and washing utensils. The decoction of the aerial parts is used to cure liver disorders, respiratory problems and menstrual problems (Choudhary et al., 2021). In the Kumaon Himalayan region, tribal people use *E. gerardiana*plant to cure asthma disease (Kumar, 2006).

c) Modern View: In the modern world, people are taking more interest in herbal medicines because of their lesser side effects, easy availability and cheaper prices. The consumption of herbal medicines has increased world widely. With the increasing demand of the people, adulteration and substitution also rise in the herbal drug industry which is considered as a major threat to the quality and in the research areas on commercial natural products. The main reason for the adulteration is the non-availability of the original plant product, deforestation, extinction of many herbal plant species, confusion in the species identification, etc. Also, many herbal dealers have developed new methods of high-quality adulteration that can only be identified by using chemical analysis and microscopic examination (Choudhary et al., 2021). The poor quality of the drug and lack of standardization are the two weaknesses that lie behind the acceptance of herbal products which results in the decreased market value of the product. So, there is a need to develop an Herbal Authentication System (HAS) which can serve as a regulator and helps in improving the quality of herbal trade (Uttra, 2017).

Reported pharmacological and therapeutic properties

Anti-arthritic: The *in vivo* and *in vitro* on the aqueous-ethanolic, n-butanol and ethyl acetate extract of the plant showed anti-arthritic activity. The *in vitro* study include thermally induced bovine serum albumin denaturation and egg albumin denaturationb and membrane stabilizing assay at a dosage of 50-6400 mg/ml.assayThe *in vivo* study include formaldehyde-induced arthritis at a dosage of 50,100 and 200 mg/kg. The crude extract and fractions was found to stabilize the red blood cells and inhibited the protein denaturation in a dose dependent manner. The maximum effect was shown at a dosage of 6,400 mg/ml. Diclofenac sodium was used as a standard drug that showed less inhibition of the protein denaturation in a dose dependent manner as compared to the crude extract and fractions of *E. gerardiana* (Younis et al., 2018).

Anti-asthmatic: The ethanolic extract of the plant was investigated *in vivo* for anti-asthmatic activity. It was found that the extract significantly decreases the albumin-induced eosinophilic inflammation of rats at a dosage of 100-200 mg/kg (Andraws et al., 2005). Also, the ethanolic extract of the plant showed positive effects against inflammation or swelling and compared with the standard drug dexamethasone. The extract showed inhibitory action against prostaglandins, histamine and serotonin mediators that are released during bronchial asthma and inflammation. Thus it showed an anti-inflammatory effect by inhibiting these mediator receptors.

Weight-loss effects: From the reported studies, it was found that the ephedrine alkaloid obtained from *E. gerardiana* plant showed positive effects in weight loss in a shorter period in both animal and plant studies, thus found to be effective against obesity. Although, the excessive use was found to be lethal as it alters the heart function that may lead to heart attack. The ephedrine alkaloid showed significant reduction in body weight in obese patients i.e. 0.9 kg weight loss / month when given at a dosage of 60 to

150 mg/day as compared to the standard drug placebo. However, there are certain limitations of its use as it is associated with certain side effects such as attrition, alters central nervous system and cardiovascular system (Pipe, 2004). This mechanism was possible through the release of norepinephrine through the hypothalamus which exerts an anorexic effect (Tutin, et al., 1965). The same activity was also noted for other drugs such as caffeine and aspirin. In another study, it was reported that the ephedra component of the plant alone results in a 14% reduction in body weight along with a decrease in body fat of approximately 42%. Moreover, when taken with caffeine and theophylline resulted in a 25% and 75% reduction in body weight with minimum side effects (Celine et al., 2016).

Antidiabetic: The antidiabetic effect of the plant was tested against alloxan-induced diabetic mice. It was found that the (-) ephedrine and (+) pseudoephedrine alkaloid component of the plant were associated with a hypoglycemic activity that stimulates the release of epinephrine that results in lowering the sugar level (Soltan and Zaki, 2009).

Antimicrobial: From the literature, it was found that the volatile oil of the ephedra exhibits significant inhibitory activity against the influenza virus (Baltch and Smith, 1994). In another study, it was also found that the methanolic extract of Ephedra species showed significant antimicrobial activity against *Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus subtilis, Colibacillus spp., Aspergillus spp., Klebsiella spp.,* and *Candida albicans* using disc diffusion method (Parsaeimehr, 2010). Also, the plant showed potent antimicrobial effects against *Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus anthracis, Staphylococcus aureus* and *Pseudomonas aeruginosa* (Taylor et al., 2002; Mack, 1997).

Cardiovascular: The ephedrine, norepinephrine and epinephrine alkaloid component of the plant stimulates the cardiac system and causes vasoconstriction via exciting the sympathetic nervous system. Also, the alkaloid component enhances the performance of cardiac indices, stimulates heartbeat and causes systolic as well as diastolic blood pressure elevation. However, from recent studies, it was found that the extracts of Ephedra shrubs contain highly active alpha and beta adrenergic agonists that directly affect the heart and vasculature which may lead to stroke, myocardial infarcation and others. (Maglione et al., 2005; WHO,1999).

Diuretic: The *in vivo* study was carried out in anesthetized dogs. The intravenously injection of D- pseudoephedrine and ephedrine components of the *E. gerardiana* plant at a dosage of 0.5-1.0 mg/kg showed diuretic effects by increasing renal blood flow, dilation of renal vessels, or hindering sodium ion reabsorption from renal tubules in anaesthetized dogs (Hong et al., 2011; Kwon et al., 2001).

CNS stimulant: The ephedrine constituent of the *E. gerardiana* plant acts as a strong CNS stimulant. The ephedrine and nor-pseudoephedrine components of the plant can pass through the blood-brain barrier and cause a significant stimulating effect on the hypothalamus and limbic system neurons which results in dopamine release, adrenaline production and which regulates heartbeat and blood pressure (Chen et al., 2004).

Nasal Decongestant effect: Pseudoephedrine and ephedrine constituents of the plant are used as nasal contestants to cure allergic rhinitis. The active constituent of the plant i.e. ephedrine is associated with a nasal decongestant activity. This alkaloid constituent acts on the sympathomimetic neurons where it stimulates the alpha-receptor activity hence results in vasoconstriction if applied on the mucosal surface of the nose and pharynx. Moreover, the alkaloid components are not effective for the nasal congestant treatment resulting from colds (Maglione et al., 2005).

Mydriatic effect: The experimental study was conducted on the eyes of 15 individuals using ephedrine hydrochloride in solutions ranging from 1 to 10 percent. Two drops of the solution was inserted 4 times in each eye at intervals of 5 minutes. The alkaloid component ephedrine of *E. gerardiana* plant cause mydriases effect i.e. dilation of pupils which occurs without pupillary light reflex blocking (Caveney et al., 2001).

Muscle Endurance effect: From the literature, it was found that the ephedrine constituent of *E. gerardiana* plant alone or with other stimulants enhance anaerobic exercise performance by stimulating the central nervous system and release of catecholamine. It is also used in other manufacturing products used for muscle development. Although, the excessive intake of the plant products can show adverse effects like heart palpitation and increase risk of GIT, autonomic and psychiatric symptoms (Howard and Lee, 1927).

Toxicity: *E. gerardiana* plant have certain toxic effects if use in over-dosage. However, it shows no potential toxicity if use in dose control. The therapeutic and pharmacological activities of the plant were found to be toxic that's why people have stopped working on the plant which created a gap of 30 years in the research area. But the reinvestigation was again done on the plant which showed its cardiac stimulant activity, a relaxant of smooth muscles of bronchi, and in elevating blood pressure like adrenaline hormone. The toxicity may cause delusions, psychosis and hallucinations (Reynolds, 1982). The overdose of the plant alkaloids showed fatal results due to heart failure and hypothermia. 1-2g dose of

ephedrine alkaloid is considered lethal. Also, the over-dosage of the plant can cause nervousness, headache, dizziness, palpitation, vomiting, insomnia, nervousness, palpitations, anxiety, seizures, nausea, hypertension, strokes, hypothermia and myocardial ischemia. Also, *E. gerardiana* plants can show hepatic injury and other indications mainly hemorrhage, vascular ischemia and vasculitis (Peters et al., 2005). In 2004, the Food and Drug Administration banned the sale of dietary supplements containing ephedra due to its toxic effects (Limberger et al., 2013). Various scientific and experimental studies revealed that the ephedra containing products depends mainly on the content of ephedrine and the other associated substances. Various clinical studies indicate that the ephedrine and other alkaloids of the plant can be safe if taken according to the recommendations of the official codes. Hence, to prevent accidents, the knowledge of the chemical composition of the species of ephedra species is essential (Soni et al., 2004).

Conclusion: From the literature study, it is quite evident that the *E. gerardiana* plant is associated with various medicinal properties. The presence of the major phytochemical constituents i.e. (-)-Ephedrine (EPH) is responsible for therapeutic actions and cure a variety of ailments such as cold, cough, chills, fever, asthma and many more. In Ayurveda, the plant acts as an anti-inflammatory, anti-arthritic and diuretic agent and is used to cure asthma, cough, chronic fever, heart diseases, uterine, contraction and others. The pharmacological activity of the plant was also studied by the scientists and researchers using different animal models and the plant was found to be anti-arthritic and anti-inflammatory. Although, the plant needs more experimental studies and clinical research to identify its more pharmacological and therapeutic properties which will be beneficial to humankind.

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Conflict of interest: None

References

Abd El-Ghani, MM. 2016. Traditional medicinal plants of Nigeria: an overview. Agriculture and Biology Journal of North America, 7(5):220-247.

Abourashed EA, El-Alfy AT, Khan IA, Walker L. 2003. Ephedra in perspective–a current review. Phytotherapy research, 17(7):703-712.

Akbar pi, malik j, lamo k. 2011. 3. Ephedra gerardiana wall: a high value medicinal plant of ornamental utility in high altitude cold arid region of himalaya. Life sciences leaflets, 21:974-to.

Andraws R, Chawla P, Brown DL. 2005. Cardiovascular effects of ephedra alkaloids: a comprehensive review. Progress in cardiovascular diseases, 47(4):217-225.

Baker G. 2010. Garden of Eden: The Shamanic Use of Psychoactive Flora and Fauna and the Study of Consciousness [Book Review]. Australian Journal of Medical Herbalism, 22(3):107.

Baltch AL, Smith RP. 1994. Pseudomonas aeruginosa: infections and treatment. Pseudomonas aeruginosa: infections and treatment, (12).

Bhattacharyya A. 1991. Ethnobotanical observations in the Ladakh region of northern Jammu and Kashmir State, India. Economic Botany, 45(3):305-8.

Calzada F, Bautista E. 2020. Plants used for the treatment of diarrhoea from Mexican flora with amoebicidal and giadicidal activity, and their phytochemical constituents. Journal of ethnopharmacology. 253:112676.

Caveney S, Charlet DA, Freitag H, Maier-Stolte M, Starratt AN. 2001. New observations on the secondary chemistry of world Ephedra (Ephedraceae). American journal of botany, 88(7):1199-1208

Celine S, Tomy S, UjwalaTK, JohnsonS, Chander U. 2016. A detailed overview of medicinal plants having hypoglycemic activity. International Journal of Phytomedicine, 8(2):139-175.Chaudhri II, 1957. Pakistan Ephedra. Economic Botany, 257-62.

Chaturvedi S, Dass S. 2011. Traditional medicinal and economic uses of gymnosperms. Bulletin of Environment, Pharmacology and Life Sciences, 1(1):70-72.

Chen, C, Biller, J, Willing, SJ, Lopez, AM, 2004. Ischemic stroke after using over the counter products containing ephedra. Journal of the neurological sciences, 217(1): 55-60.

Choudhary S, Kaurav H, Madhusudan S, Chaudhary G. 2021. Daruharidra (Berberisaristata): Review based upon its Ayurvedic Properties. International Journal for Research in Applied Sciences and Biotechnology, 8(2):98-106.

Choudhary, S, Kaurav, H Chaudhary, G. 2021. Kasanibeej (Cichorium intybus): Ayurvedic View, Folk View, Phytochemistry and Modern Therapeutic Uses. International Journal for Research in Applied Sciences and Biotechnology, 8(2):114-125.

Chukwuma EC, Soladoye MO, Feyisola RT. 2015. Traditional medicine and the future of medicinal Plants in Nigeria. Journal of Medicinal Plants Studies, 3(4):23-29.

Friedman WE. 1996. Introduction to biology and evolution of the Gnetales. International Journal of Plant Sciences, 157(S6):S1-S2.

Gaur RD, Sharma J. 2011. Indigenous knowledge on the utilization of medicinal plant diversity in the Siwalik region of Garhwal Himalaya, Uttarakhand. Journal of forest and environmental science, 27(1):23-31.

Gen XP. 1986. Medicinal plants: the chinese approach. In World Health Organization Forum, 7:84-85.

Ghorbani A. 2005. Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran:(Part 1): General results. Journal of ethnopharmacology, 102(1):58-68.

Gurmet P, Stobgais T. 2016. A handbook on medicinal plants of Himalayas used in Sowa-Rigpa. Digi Lab and Print house Ladakh.

Hong H, Chen HB, Yang DH, Shang MY, Wang X, Cai SQ, Mikage M. 2011. Comparison of contents of five ephedrine alkaloids in three official origins of Ephedra Herb in China by high-performance liquid chromatography. Journal of natural medicines, 65(3):623-628.

Howard HJ, Lee TP. 1927. The Effect of Instillations of Ephedrine Solution Upon the Eye. Proceedings of the Society for Experimental Biology and Medicine, 24(7):700-702.

HussainM, ShahGM, KhanMA, 2006. Traditional medicinal and economic uses of Gymnosperms of Kaghan valley, Pakistan. Ethnobotanical Leaflets, 2006(1):7.

Ichim, MC, 2019. The DNA-based authentication of commercial herbal products reveals their globally widespread adulteration. Frontiers in pharmacology, 10:1227.

Konno C, Taguchi T, Tamada M, Hikino H. 1979. Ephedroxane, anti-inflammatory principle of Ephedra herbs [drug plants]. Phytochemistry, 18:697-698.

Kumar jsjp. 2006. Some ethno-medicinal plants of gori river easin, kumaon himalaya. Flora, 12(2):292-294.

Kumari I, Kaurav H, Chaudhary G, 2021. Ethnobotanical Significance of PicrorhizaKurroa (Kutki), a Threatened Species. April; 8(4):363-375.

Kumari I, Chaudhary G, Kaurav H. 2021. Holarrhena antidysenterica (Wall.) Kutaja: Medicinal Plant with high steroidal alkaloid profile, 11(2):125-34.

Kwon yb, lee jd, lee hj, han hj, mar wc, kangsk, beitz aj, lee jh. 2001. Bee venom injection into an acupuncture point reduces arthritis associated edema and nociceptive responses. Pain, 90(3):271-280.

Leung AY. 1990. Chinese medicinals. Advances in New Crops. Timber Press, Portland, OR:499-510.

Lifongo LL, Simoben CV, Ntie-Kang F, Babiaka SB, Judson PN. 2014. A bioactivity versus ethnobotanical survey of medicinal plants from Nigeria, West Africa. Natural products and bioprospecting, 4(1):1-19.

Limberger RP, Jacques ALB, Schmitt G, Arbo MD. 2012. Pharmacological Effects of Ephedrine, 38:1217-1233

MackRB. 1997. "All but Death, Can Be Adjusted". Ma Huang (Ephedrine) Adversities. North Carolina medical journal, 58(1):68-70.

Maglione M, Miotto K, Iguchi M, Jungvig L, Morton SC, Shekelle PG. 2005. Psychiatric effects of ephedra use: an analysis of Food and Drug Administration reports of adverse events. American Journal of Psychiatry, 162(1):189-191.

Manandhar NP. 1980. Medicinal plants of Nepal Himalaya Ratna Pustak Bhandar. Bhotahity, Kathmandu, Nepal; 581.

Morton JF. 1977. Major medicinal plants: botany, culture and uses (No. 04; QK99. A1, M6.).

Musselman LJ. 1996. Encyclopedia of Common Natural Ingredients Used in Food, Drugs, and Cosmetics, ed. 2. Albert T. Leung, and Steven Foster; 422.

Nair, Kalariya T, Chanda S. 2005. Antibacterial activity of some selected Indian medicinal flora. Turkish Journal of biology, 29(1):41-47.

Navchoo IA, Buth GM. 1992. Ethnobotany of Ladakh, Jammu and Kashmir State. Journal of Economic and Taxonomic Botany Additional Series, 10:251-8.

Parsaeimehr A, Sargsyan E, Javidnia K. 2010. A comparative study of the antibacterial, antifungal and antioxidant activity and total content of phenolic compounds of cell cultures and wild plants of three endemic species of Ephedra. Molecules, 15(3):1668-78.

PetersCM, O'neill JO, YoungJB, Bott-SilvermanC. 2005. Is there an association between ephedra and heart failure? a case series. Journal of cardiac failure, 11(1):9-11.

Pipe A. 2004. Efficacy and safety of ephedra and ephedrine for weight loss and athletic performance. Clinical Journal of Sport Medicine, 14(3):188-9.

Reynolds JE. 1982. Martindale: the extra pharmacopoeia. London, UK; The Pharmaceutical Press.

Rinchen T, Gurmet P, Dolker P,Stobgais T. 2021. Cultivation and population status of Ephedra (Ephedra gerardiana Wall. Ex Stapf) critically endangered medicinal plant for the conservation in cold desert of Ladakh, India;2-6.

Rungsung w, dutta s, ratha kk, mondal dn, hazra j. 2002. Pharmacognostical and phytochemical study on the stem of ephedra gerardiana. methods, 14:15.

Salazar JR, Loza-Mejía MA, Soto-CabreraD. 2020. Chemistry, biological activities and in silicobioprospection of sterols and triterpenes from Mexican columnar cactaceae. Molecules, 25(7):1649.

Sharma AP. 1956. Dravyaguna vidnyan. Part II Chaukhamba Vidya Bhavan Chowk, Banaras.

Simmler C, Graham JG, Chen SN, Pauli GF. 2018. Integrated analytical assets aid botanical authenticity and

adulteration management. Fitoterapia, 129:401-414.

Soltan MM, Zaki AK. 2009. Antiviral screening of forty-two Egyptian medicinal plants. Journal of ethnopharmacology, 126(1):102-107.

SoniMG, Carabin IG, GriffithsJC, Burdock GA. 2004. Safety of ephedra: lessons learned. Toxicology letters, 150(1):97-110.

Sukumaran S, Raj ADS. 2010. Medicinal plants of sacred groves in Kanyakumari district Southern Western Ghats, 9(2):294-299.

Tai W. 2003. The essentials of traditional Chinese herbal medicine. Foreign Languages Press.

Taylor G, Gravel D, Johnston L, Embil J, Holton D, Paton S. 2002. Canadian Hospital Epidemiology Committee and Canadian Nosocomial Infection Surveillance Program. Prospective surveillance for primary bloodstream infections occurring in Canadian hemodialysis units. Infection Control & Hospital Epidemiology, 23(12):716-720.

Thakur S, Kaurav H, Chaudhary G. 2021. A Review on Woodfordia fruticosa Kurz (Dhatki): Ayurvedic, Folk and Modern Uses. Journal of Drug Delivery and Therapeutics, 11(3):126-31.

Tutin TG, Heywood VH, Burges NA, Valentine DH, Walters SM, Webb DA. 1964. Flora Europaea. Lycopodiaceae to Platanaceae. Flora Europaea. Lycopodiaceae to Platanaceae, 1:498.

Uttra AM. 2017. Assessment of antiarthritic potential of Ephedra gerardiana by in vitro and in vivo methods.Bangladesh Journal of Pharmacology, 12(4):403-409.

Verma S, Singh SP. 2008. Current and future status of herbal medicines. Veterinary world, 1(11):347.

World Health Organization. 1999. WHO monographs on selected medicinal plants (Vol. 2). World Health Organization.

Yadav RNS, Agarwala M. 2011. Phytochemical analysis of some medicinal plants. Journal of phytology, 3(12):10-14.

Yorek N, Aydin H, Ugulu I, Dogan Y. 2008. An Investigation on Students' Perceptions of Biodiversity. Online Submission, 7(3):175-184.

Younis W, Asif H, Sharif A, Riaz H, Bukhari IA, Assiri AM. 2018. Traditional medicinal plants used for respiratory disorders in Pakistan: a review of the ethno-medicinal and pharmacological evidence. Chinese medicine, 13(1):1-29.

Zhu YP. 1998. Chinese materiamedica: chemistry, pharmacology and applications. CRC press.