

A review on experimental analysis and *In vitro* propagation of *Nardostachys jatamansi*

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Abstract

Nardostachys jatamansi is a perennial herb found mainly in temperate and Alpine Himalayas. *N. jatamansi* is herbal supplements and medicine both in daily self-care and in a professionally managed health care system. It is used to treat disorders related to nerve, digestive, circulatory, respiratory, urinary and reproductive systems as well as skin problems. All plant parts of *N. jatamansi* are used as effective antipyretics, antiseptics, anticonvulsants, antispasmodics, antibacterial, antipyretics, antifungals, antiemetic and analgesics.

Keywords: *Nardostachys jatamansi*, perennial herb, herbal supplements, medicine, health care system, etc

Introduction: Review

Nardostachys jatamansi is a small, perennial, rhizomatous flowering plant of the valerian family. It grows in the Pakistan, Nepal, Tibet, China and Himalayan regions of India in between 3500-5000 m. It is a natural source of essential aromatic amber colored oil. Since ancient times, plant oil had been used as a perfume, medicine and in religious context (Airi *et al.*, 2000) [4]. *In vitro* studies provide an optimum culture condition for steady and quality production of bioactive chemicals throughout the year without involvement of environmental stresses (Gaurav *et al.*, 2016) [16].

Common Names: Spikenard, Jatamansi, Nard, Nardin or Muskroot. Mounting evidences shows that it is critically endangered (as rated by the IUCN) in the wild due to over harvesting for medicine, forest degradation, overgrazing and loss of habitat (Bakhrū *et al.*, 1993; Nadkarni *et al.*, 1954) [6].

Scientific Classification of *Nardostachys jatamansi*

Kingdom - Plantae
Division - Mangnoliophyta
Order - Dipsacales
Class - Mangnoliopsida
Genus - *Nardostachys*
Species - *jatamansi*

Habit & Habitat: It is mostly terrestrial and occurs in alpine temperate forest between 3200-5000 m on the rocky and undisturbed slopes or on stones with coarse sandy foam soils. It generally prefers to grow in steep hills, inclined slopes and in more frequent on open, stony, and grass slopes. The *jatamansi* species is found to be distributed in the subalpine to alpine areas of India (Jammu and Kashmir, Himanchal Pradesh, Uttarakhand, Sikkim), Pakistan, Nepal, Tibet, China and Yunan (Kiritkar and Basu *et al.*, 1991) [19].

Botany: Perennial herb with a cylindrical rhizome, covered with brown to deepgrayish fibers, rootstock woody, long and stout, covered with fibers from the petioles of withered leaves. Stem 10-60 cm, more or less pubescent upwards, often glabrate below, subscapose. Adventitious roots thin,

branched and red to brown in color. Flower rosy, pale pink or blue in dense cymes. Flower-heads usually 1, bracts 3 or 5, 6 mm long, usually pubescent corolla-tube 6 mm long somewhat hairy within, as are the filaments below. Fruit 4 mm long, covered with ascending white hairs, crowned by the ovate, acute, often dentate, calyx-teeth. Odor slight and aromatic and taste is acrid, slightly bitter and aromatic (Kirthikar and Basu *et al.*, 1991) [19].

Plant Propagation: The *in vitro* tissue culture technique is now being used globally for the multiplication of medicinally important plant species and also responsible to produce large numbers of secondary metabolites (Gaurav *et al.*, 2018) [17]. The plant is propagated by cutting of underground parts and sometimes by seeds. It is valued for its rhizomes (commonly called roots) used in India as a drug and also in perfumery (Wealth of India, 1997).

Chemical Composition of *jatamansi*: Sastry *et al.*, 2017 [36] has described that the different biochemical substance found in this medicinal plant such as Ursolic acid, acacin, kanshone A, octacosanol, nardosinone, nardosinonediol, aristolen-9-beta-ol, oleanolic acid, beta-sitosterol. It also contains nardal, jatamansic acid, jatamol A and B, spirojatamol, terpenoid, neolignans, taraxerone, valeranone, chlorogenic acid, ferulic acid, syringic acid and photocatechic acid.

In roots sesquiterpene, ketone-jatamansone, liquid alcohols-nardol, calarenol and n-hexacosanol, a ketone valeranone and diethenoid ketone- nardostachane, n-hexacosen, n-hexacosanyl isovalerate, isovaleric acid, valeranone and β -sitosterol found (Govindachari *et al.*, 1959) [15].

Application of *Nardostachys jatamansi*: Rahman *et al.*, 2011 [32] has explained the application of *N. jatamansi*. According to him it is a natural brain nerve tonic and amemory enhancer, which has calming, peacefulness and relaxation features. It is an endangered Ayurvedic medical herb had been used since the ancient times for many medicinal purposes. In the market, it is available in the form of root, oil, and powder. *N. jatamansi* is a known calming herb in Ayurveda and unani because of its medicinal values. A number of studies have been done for its efficacy in

respect of nervous system. In Ayurveda, it is prescribed against stress, spasm, epilepsy, convulsion and hysteria. In fact, it is one of the excellent herbs to treat epilepsy (Sahu *et al.*, 2016)^[34].

Ayush-56: It is an amalgam of *N. jatamansi* and *Marsilea minuta* with the ratio of 1:2. It is used as anti-epileptic.

Antidepressant: The extract of *N. jatamansi* show antidepressant features (Sahu *et al.*, 2016)^[34].

Antifungal: The essential oil of it acts against fungus like *Aspergillus flavus* and *Aspergillus Niger* (Sahu *et al.*, 2016)^[34].

As a Medicine: Used since ancient times as a medicine for curing mental retardation, heart diseases, insomnia and urine related problems. The essential oil, known as spike nard oil, antiarrhythmic activity with possible therapeutic useful to treat auricular flutter. The oil exerts a hypotensive effect and in moderate doses it has a distinct depressant action on the central nervous system. The volatile oil from the rhizomes is very effective in leprosy (Chopra *et al.*, 1954)^[11].

Cardiac Health: It ensures good cardiac condition as observed in mice (Arora and Madan *et al.*, 1956)^[3].

Hair Growth: The extract of *jatamansi* oil is helpful in the growth of hair. It is beneficial for smooth, silky and healthy hair too. It is used to improve complexion and ensures glowing and shining looks to the body. The root of the powder in water when applied promotes skin texture (Ambasta S.P., 1986)^[5].

Liver Problems: It shows hepatoprotective effects along with *Momordica charantia* and *Ferula asafetida*. It is also useful in hepatitis, prevent enlargement of liver and jaundice. The root of the powder is used to treat intestinal worms (Nadkarni *et al.*, 1986)^[26].

Memory and Learning: The medicinal plant is helpful in enhancing the faculties of the brain and combats the mental problems thus impart calm and peace to mind. It is one of the effective medicinal roots to subsidize the three humors- vatta, pitta and kapha and provides delightful state to the doshas of the body (Ambasta *et al.*, 1986)^[5].

Reduce Hyperactivity: It is beneficial for hyperactive children and helpful to reduce hyperactivity, restlessness and aggressiveness (S ali *et al.*, 2000)

Strengthens the Nervous System: It helps to provide vitality, vigor and strength to the body thus good for the nervous system (Mukherjee *et al.*, 2007)^[25]

Stress Buster: The plant has the power to reduce stress, anxiety and tension by balancing biochemical reactions in the body. It is good to have the mind cool and healthy and acts as one of the finest mind rejuvenator tonic. It facilitates sound sleeping thus good for those who have stressful life (Nazmum *et al.*, 2009)

Skin Infection: The burning sensation of skin and inflammation get subsidized when the decoction of *jatamansi* powder prepared in cold water is applied (Bagchi *et al.*, 1991)^[7]

Snake bite: The rhizome in combination with other drugs is prescribed in snake bite and scorpion-sting (Kirtikar and Basu *et al.*, 1991)^[19]

Urinary Problem: In unani medicine system it is used as a diuretic (Ambasta *et al.*, 1986)^[5].

Wide Range of Disorders: *Jatamansi* has been traditionally used in treatment of wide range of disorders, which include digestive system, circulatory system, nervous system, respiratory system, urinary system, reproductive system and skin diseases (Chopra *et al.*, 1954)^[12].

Essential Oil Information: The plant used for extracting the oil is a tender aromatic herb, native to mountainous regions of northern India, as well as China and Japan.

This oil was used by roman perfumers. It is known to be one of the Early aromatic used by the ancient Egyptians and is also mentioned in the bible (Mulliken *et al.*, 2000)^[24].

Oil properties: The oil of *N. jatamansi* has a woody fragrance which is warm, herbaceous, aromatic and sensual. The fragrance in this oil is the combination of resinous, sweet, spicy and animal-fat odors. The essential oil gives fragrance like an organic earthy scent (Mulliken *et al.*, 2000)^[24].

Other Uses: Used as making of perfumes and dyes. Prescribed for hemorrhoids, edema gout, arthritis, obstinate skin diseases and fractures. Also used in aromatherapy to remove tension and stress from the mind. It can be effective as a deodorant in case of excessive sweating. Useful for smooth, silky and healthy hair. Also added to the formulations of lotions, soaps, scents, massage oils, body fragrance, air fresheners and aromatherapy product (Chopra *et al.*, 1956)^[11].

According to Mulliken *et al.*, (2000)^[24] the herb *N. jatamansi*, is known to be a popular medicinal and aromatic plant species. It is a reputed Ayurvedic herb and used in various multiple formulations. It has also been mentioned in the Holy Bible and Quran. The roots and rhizome of *N. jatamansi* have been used to treat epilepsy, hysteria, syncope and mental weakness. It also exhibits cardio protective activity and used in the treatment of neural diseases.

Mathur and his coworkers (1993) were established callus cultures of *N. jatamansi* (an endangered medicinal and aromatic plant) by using petiole explants on MS medium supplemented with 16.1 μM α-naphthaleneacetic acid and 1.16 μM Kinetin. Embryogenesis in these callus cultures took place only upon sequential subculture of the callus on media having gradually decreasing auxin (16.1 to 1.34 μM NAA) and simultaneously increasing cytokinin (1.16 to 9.30 μM kinetin) concentrations over a period of 7 months. Somatic embryo to plantlet conversion took place on a medium containing 9.30 μM kinetin and 1.34 μM NAA.

Phytochemical Compound of *Nardostachys jatamansi*: Ahmad *et al.*, (2013)^[1] have studied the physico chemical properties such as the percentage of total ash, acid insoluble ash, water soluble ash, alcohol soluble and water soluble extractive values were determined as per the standard procedure. Percentage of ash value is indicative of the purity of the drug and extractive values represent the presence of polar and non-polar compounds.

This hairy, perennial, dwarf and herbaceous plant are used for medicinal purpose. Mostly herbs and rhizome are used for this hairy, perennial, dwarf and herbaceous plant. *N. jatamansi* has been reported to have many therapeutic activities like antifungal, antimicrobial, antioxidant, hepatoprotective and cardioprotective properties. It is also useful in the management of insomnia and CNS disorders. In phytochemical analysis *jatamansone*, *Nardostachone* and *actinidine* have been reported to be present in the plant. This review article is summary of the potential benefits of this medicinal plant as reported in literature. The review also highlights the need for the use of this plant in Ayurveda system of medicine and future prospects for further research.

Jatamansic acid, *nardostachone*, *nardol* and other

constituents are resin, sugar, starch, bitter extractive matter and gum. All the parts of *N. jatamansi* and chemical constituents are used as antiseptic, anticonvulsant, antispasmodic, antibacterial, antipyretic, antifungal, antidote, antiemetic, analgesic, anxiety. This article highlights some of the chief constituents and their biological activities and uses of various parts of *N. jatamansi* (Jadhav *et al.*, 2009) [18].

According to the experimental analysis of Archana *et al.*, (2015) the chemical composition of *N. jatamansi* is highly complex containing volatile essential oil and other biological active compounds. Although all parts including roots and rhizomes have significant and differing medicinal properties. The principle compound Jatamansone obtained from the rhizomes. Twenty-one compounds were identified in *Valeriana jatamansi* root oil by GC and GC-MS. The major compounds identified were patchouli alcohol (0.4-63.7%), maaliol (2.9-53.8%), seychellene (4.1-27.4%), calarene/ β -gurjunene (3.0-20.8%), α -santalene (0.6-12.0%). Other compounds present were bormyl acetate (0.6-1.5%), α -guaiene (0.7-2.3%), α -bulnesene/d-guaiene (0.7-6.3%), 7-epi- α -selinene (0.4-1.4%), kessane (2.1-3.3%), spathulenol (0.7-3.4%), viridiflorol (0.9-7.1%), α -patchoulene (0.8-6.6%), β -patchoulene (0.4-0.8%). Two superior chemotypes identified in Valeria jatamansi oil from Uttarakhand were: patchouli alcohol rich (IC573221, 63.7%) and maaliol rich (IC573222, 53.8%, IC589096, 51.7%). These superior chemotypes with higher amounts of patchouli alcohol and maaliol could be used for promoting cultivation as well as for meeting need of pharmaceutical industries.

The review of Nakoti *et al.*, (2017) [27] summarizes phytochemical and pharmacological investigations carried out on the plant. *Nardostachys jatamansi* contains a number of bioactive chemicals, including crystalline acid, hydrocarbons, a polyoxygenated crystalline solid together with A-endesmol, B-eudesmol, ethanol, angelicin, 4-hydroxythymol dimethylether. The present review detailed focus on its pharmacognostical, pharmacodynamics, pharmacological studies and its therapeutic importance in drugs.

Sesquiterpenes and coumarins are present in considerable amount in the root of *jatamansi* plant mainly responsible for its essential oil. Various other sesquiterpenes known are nardostachone, dihydro jatamansin, jatamansinol, jatamansic acid, jatamansinone, jatamansinol, oroseolol, oroselone, seslin, valeranal, nardostachyin, nardosinone, s pirojatamol, jatamol A and B, calarenol, seychellene, coumarin: jatamansin or xanthogalin. (Jigmet disket *et al.*, 2012) [13]

Biological Activity of Plant Material

Antimicrobial Activity: Singh *et al.*, (2013) [39] experiments on antimicrobial susceptibility test for various fractions was performed using Agar well diffusion method. The strains of *E.coli*, *K.pneumonia*, *P.aeruginosa*, *S.typhimurium*, *S.aureus* and *M.luteus* were used for susceptibility test. Various fractions of *N.jatamansi* root extract were loaded in separate wells of 6mm diameter each. Zone of inhibition value against *E.coli* was found to be highest by all fractions representing this species most susceptible. On the other hand n-butanol and hexane fractions showed significant inhibition to all the species taken representing these fractions most active. Aqueous

fraction was found to be least active against most of the species taken.

Chandrasekhar *et al.*, (2013) [9] performed the bacterial reverse mutation test with *N.jatamansi* plant rhizome powder using *salmonella typhimurium* tester strains and substantial increase in revertant colony number was not observed in the presence and absence of metabolic activation system up to the dose 5.0 mg/plate. Parveen *et al.*, (2011) [30] studied the antibacterial effect of the essential oil of *N.jatamansi* roots and among gram-positive bacteria oil exhibited maximum antibacterial activity against *B.subtilis* followed by *S.aureus* and gram-negative bacteria only *K.pneumoniae* and *E.aerogenes* were found to be sensitive. The antimicrobial activity of ethanol, ethyl acetate and hexane extracts. *N.jatamansi* roots was studied by Sohail *et al.*, (2007) among which ethanol root extract exhibited maximum antimicrobial activity against all the tested bacteria and fungi, at concentrations of 5, 10 and 20 mg/ml.

Anticancer Activity: *Nardostachys jatamansi* is a Himalayan medicinal herb that has been described in various traditional systems of Medicine for its use in cancer. In view of its traditional claims, and chemical constituents, antioxidant and anticancer activities were evaluated in breast carcinoma. (Vajrabhaya *et al.*, 2018) [43]

According Chaudhary *et al.*, 2015 [10] to experiment Petroleum ether (NJPE), methanol extract (NJM) and subsequent diethyl ether (NJDE), ethyl acetate (NJE) and aqueous (NJAQ) fractions of roots and rhizomes of *N.jatamansi* were prepared. Total phenolic, flavonoid content and antioxidant activities were determined using suitable methods. Antiproliferative activity was assessed in estrogen receptor (ER)-positive (MCF-7) and ER-negative breast carcinoma (MDA-MB-231) cells by MTT and SRB assay. Cell cycle analysis, Hoechst staining, and clonogenic assay were employed to determine the mode of antiproliferative and pro-apoptotic activity in MDA-MB-231 cells. NJM/fraction possess significant antiproliferative potential which is mediated through cell cycle perturbation and pro-apoptotic effects in MDA-MB-231 cells. Moreover, this study highlights the antioxidant potential of NJM/fractions which can be attributed to the presence of phenols. NJDE emerged as the most potent fraction and further mechanistic and phytochemical investigations are under way to identify the active principles.

Bhagat *et al.*, (2013) [8] studied that the roots of *Nardostachys jatamansi* a well-known traditional medicinal plant was explored for *in vitro* antiproliferative potential against two neuroblastoma human cancer cell lines viz., IMR-32 and SK-N-SH using SRB assay. There were no significant differences between the two cytotoxicity assays ($P > 0.05$). The ICC values showing the agreement of the two assays in the negative and positive control group and herb concentration of 0.01, 0.1, 0.25, and 0.5% were 0.93 and 0.99 and 0.53, 0.51, 0.95 and 0.98 respectively.

Antioxidants Activity: The rhizomes of *Nardostachys jatamansi*, the plant commonly known as jatamansi have been described in Ayurveda for their soothing and sedative action on the central nervous system. (Rasheed *et al.*, 2018) [33] Result

Mathew *et al.*, (2014) [22] studied antioxidant activity of *N.jatamansi* by DPPH scavenging assay with IC50 value <10g/ml.

Mishra *et al.*, (2014) prepared herbal antioxidant face cream from the ethanol extract of *N.jatamansi* and showed value of

58.39g/ml.

Panday *et al.*, (2013) was analyzed by antioxidant activities of methanol extract of *N.jatamansi* were found to contain only protocatechuic and syringic acids.

Dugahesh *et al.*, (2013) [14] studied the antioxidant effect of *N.jatamansi*, which inhibited beta-carotene oxidation. The calibration curve of valerenic acid was linear in the range of 2-51mg/l. The antioxidative potential of a hydroethanolic extract of *N.jatamansi* (NJE) rhizomes were studied by Sharma *et al.*, (2012) [37] that exhibited free radical scavenging, against DPPH and superoxide anions and the extract exhibited high reduction capability and powerful free radical scavenging, especially against DPPH and superoxide anions as well as a moderate effect on No.

The antioxidant potential of *N.jatamansi* was examined by Kumari *et al.*, (2010) [20] and *in-vitro* lipid peroxidation was reported due to the presence of phenols, flavonoids and alkaloids. The antioxidant effects of NJE which tended to normalize augmented lipid peroxidation, nitrite, superoxide dismutase activities and catalase level were studied by Lyle *et al.*, (2009) [21] evaluated the antioxidant effect of hydro-ethanol extract (70%) of *N.jatamansi* (NJE) that reversed the stress-induced elevation of LPO and NO levels.

Neuroprotective Activity: Salim *et al.*, (2003) [35] described that Pretreatment with an alcoholic extract of *N.jatamansi* dosed at 250mg/kg of for 15 days protected rats against focal ischemia caused by middle cerebral artery occlusion. The protective effect may be associated with improving glutathione content, inhibiting lipid per oxidation, and activity on the Na⁺/K⁺ ATPase and catalase enzyme systems.

Discussion

N. jatamansi is an essential herb with multiple remedies. It contains chemicals of various classes such as fixed oils, alkaloids, flavonoids, tannins, saponin, proteins and amino acids, carbohydrates, terpenoids, glycosides and lactones. The rhizome of the herb is used in various Ayurvedic formulations and has a history of use as an essential oil known to be effective for insomnia, stress and tension. It is used in various Tibetan healing incenses. As its demand in the market increases, the chances of its variation increases. Its antitonic activity could be explored in more details thereby increasing the possibility of developing new drugs.

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