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Morphology, Pharmacognosy of *Strychnos nux-vomica* and *S. potatorum* and their Medicinal Importance in Traditional Systems: A Review

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ABSTRACT

The species *Strychnos nux-vomica* and *Strychnos potatorum* Linn., which belong to the Loganiaceae family, are used in traditional medicine to treat gonorrhoea, leukorrhea, gastropathy, bronchitis, chronic diarrhoea, dysentery, renal and vesicle calculi, diabetes, conjunctivitis, scleritis, ulcers, and other eye diseases. This medicinal species has been highlighted in an effort through pharmacological and phytochemical research. The morphology, phenology, distribution, phytochemical analysis, and pharmacological screening of *Strychnos potatorum* and *nux-vomica*, two significant medicinal plants, are the subjects of the current review. The gathered data may serve as the foundation for its widespread application as a therapeutic agent in both conventional and alternative medicine.

Keywords Pharmacological, Phytochemical, *Strychnos nux-vomica*, *Strychnos potatorum*.

INTRODUCTION

From ancient times to the present, medicinal plants have been employed as a source of medications for the treatment of several illnesses affecting both humans and cattle. Involving the World Health Organization (WHO), there are 250,000 kinds of flowering plants that are classified as therapeutic plants in total. According to the World Health Organization, up to 80% of people still primarily use traditional treatments like herbs for their medical care (Kala 2005). Almost 1500 of India's 45000 plant species are classified as rare or vulnerable (Myers 1988). People from all walks of life are given access to their main healthcare services. They perform as crucial therapeutic agents and crucial raw materials for the production of both conventional and contemporary medications. High demand for medicinal plants results in overuse, habitat loss, environmental degradation, all of which contribute to the extinction of species from their native habitat (Yadav *et al.* 2014). There are several medicinal plants in forests that may treat and prevent a wide range of illnesses. Strychnos nux-vomica and *Strychnos potatorum* are two significant medicinal trees, and for a very long time, many Asian nations

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have employed their bark, leaves, roots, seeds, and fruits in traditional medicine formulations.

***Strychnos nux-vomica* Linn.**
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In English, the species is known as nux, strychnine tree, semen strychnos, poison nut, dog button, quaker buttons, snake wood, and vomic nuts, in Hindi, it is known as Bailewala, Kuchla; and in Marathi, it is known as Kajra, Kuchla, Kupilu, and so on (Arivoli and Tennyson 2012, Bhati *et al.* 2012, Behera *et al.* 2017, Kanta and Banerji 2017). It possesses low cost with no environmental loss as compared to synthetic insecticides (Thambi and Cherian 2015, Tari *et al.* 2020).

Distribution and habitat

A useful medicinal plant called *Strychnos nux-vomica* Linn. (Loganiaceae) is endemic to Southeast Asia, particularly India, Burma, and Pakistan (Razzaq *et al.* 2020, Patel *et al.* 2017). It is often seen in wet deciduous and semi-evergreen forests of West Bengal, Bihar, Maharashtra, Odisha, Central and South India up to 500 m msl (Behera *et al.* 2018). Commercial growing has been recorded in the United States, the European Union, Fujian, Guangdong, Guangxi, Hainan, North Australia, Taiwan, and other tropical Asian countries (Patel *et al.* 2012). In India, just a small portion of the southern states are known to practise commercial production (Behera *et al.* 2018). For its toxic constituents' strychnine and brucine, the drug plant Nux-vomica is highly esteemed in many ancient systems of medicine, including Unani, Ayurveda, Tibetan, Chinese, and homoeopathy (Behera *et al.* 2018).

Morphology and phenology

It is a large, 12-meter-tall deciduous tree (Akbar 2020). A slow growing small to medium sized evergreen tree, easily recognizable with its round canopy, smooth black granular bark, broadly ovate dark green shining foliage with distinct venation, globose, orange yellow woody fruits (Schmelzer and Gurib-Fakim 2008, Behera *et al.* 2018). Flowering occurs between mid-February and mid-March and continue until the end of April. Fruits mature in around 10 to 11 months and become orange red when they are ripe (Behera *et al.* 2018).

Phytochemical constituents

Phytoconstituents isolated from seeds are alkaloids; major alkaloids being strychnine (1.23%) and brucine (dimethoxy strychnine) (Subbaiah and Savithramma 2014) (1.55%) ; CLI other constituents, and minor alkaloids include struxine, a- and b-colubrine, pseudo strychnine, strychnine N-oxide, proto strychnine, n-oxystrychnine, brucine N-oxide, novacine, icajine, vomicine, isostrychnine, isobrucine, isobrucine N-oxide, and isostrychnine N-oxide (Bhati *et al.* 2012, Yang *et al.* 2010), the glycoside longanin,CXI chlorogenic acid mannosan, and galactan, strynuxlines A and B (Fu *et al.* 2012). Three bisindolomonoterpenic alkaloids that exhibit *in vitro* antiplasmodial activity against chloroquine-sensitive and resistant strains, together with strychnochrysine, from the stem bark (Jonville *et al.* 2013), strychnochrysine from roots and five phenolic compounds, kaempferol 7-glucoside, 7-hydroxycoumarin, quercetin-3-rhamnoside, kaempferol 3-rutinoside, and rutin from leaves (Eldahshan and Abdel-Daim 2015) have been isolated. Dried ripe seeds (Maqianzi) contain 1–1.4% each of strychnine and brucine (Chan 2002).

The overall number of alkaloids in seeds ranges from 2.6 to 3.0%, with strychnine accounting for 1.25 to 2.5% and brucine for 1.5 to 1.7%. The seeds also contain 3.0% fixed oil, a glycoside called loganin, and chlorogenic acid (Mohesh *et al.* 2015, Behera *et al.* 2018).

SNV phytoconstituents strychnine, brucine, strychnicine and glycosides including loganin, caffeotannic acid, and traces of copper have all been documented to be present in SNV phytochemically (Muthuthanthirige *et al.* 2020, Yadav *et al.* 2014) and are enlisted in Table 1. The dried blooms have a strychnine content of 1.023%, whereas the seeds have about 1.5% (Behera *et al.* 2018).

Pharmacological studies

The idea that the plant species may treat a variety of ailments greatly increased the plant's appeal. This plant actually holds a distinct place in several medical

Table 1. Phytochemicals constituents of *Strychnos nux-vomica*.

Sl. No.	Secondary metabolites	Chemical component	Part	Reference
1	Alkaloids	Strychnine	Processed seeds	Zhang *et al*. (2012)
2		Brucine	Processed seeds	Zhang *et al*. (2012)
3		Strychnine-N-oxide	Seeds	Cai *et al.* (1994)
4		Brucine-N-oxide	Seeds seeds	Cai *et al.* (1994)
5		Strychnoflavine	Stem bark	Jonville *et al.* (2013)
6		Strychnochrysine	Stem bark	Jonville *et al.* (2013)
7		Strychnine methiodide	Fruit	Liu (2010)
8	Iridoid glycosides	6^0 -O-Acetylloganic acid	Seeds	Zhang *et al.* (2003)
9		Loganin	Fruit	Liu and Li (1998)
10	Organic acids and phenols	Protocatechuic acid	Fruit	Liu (2010)
11		Gallic acid	Fruit	Liu (2010)
12		Caffeic acid	seeds	Zhang *et al.* (2012)
13		p-Hydroxy phenylacetic acid	seeds	Zhang *et al.* (2012)
14	Triterpenoids and steroids	β-Simiarenol	Fruit	Liu (2010)
15		Ursolic acid	Fruit	Liu (2010)

systems due to its extensive therapeutic significance. SNV has thus been well explored in Chinese medicine, which supports its unique traditional medicinal potential (Patel *et al.* 2017).

Strychnine shown exceptional negative chronoscopic action on frog separated heart and guinea pig atria, and activity was also preserved *in vivo*. It also exhibited anti-HIV, hepatoprotective, anticholestatic, anti-ant lipid peroxidative property, antiulcer, and insecticidal properties (Mitesh *et al.* 2015).

Antimicrobial activity

Plant extracts from Nux-vomica have antibacterial and antifungal activities. Silver nanoparticles (SNPs) from *Strychnos nux-vomica* have good antimicrobial activity against a variety of microorganisms, including *Escherichia coli, Bacillus subtilis, Staphylococcus aureus*, *Salmonella typhi* species of bacteria, and *Paecilomyces varioti, Pencillium rubrum*, and *Aspergilus flavus* species of fungi. SNPs are produced by heating (Subbaiah and Savithramma 2014). Rice seeds were used to assess the effectiveness of aqueous extracts of various SNV components against *T. alternaria.* The outcome demonstrated that stem, bark, and seed extract had a more significant impact than the other components (Patel *et al.* 2017).

Rodenticide properties

In the early 1990s, the United States and several European nations employed the alkaloid strychnine derived from nux-vomica seed extract to eradicate rats used sometimes to kill stray cats, dogs, birds, and other pests. Because there were no data on its health and safety before 2006, it was prohibited. In America, strychnine is only now approved for usage as a bait application to control pocket gophers (Patocka 2015)

Insecticidal and nematicidal properties

Extracts from seeds, leaves, and stems have insecticide and nematicide characteristics. The third instar larvae of the filariasis-causing *Wuchereria bancrofti* mosquito, *Culex quinquefasciatus*, are fatal to ethyl acetate leaf extract at 200 ppm (Arivoli and Tennyson 2012, Thambi and Cherian 2015) observed that rice weevil *Sitophilus oryzae* L. was harmful to ethyl acetate leaf extract at 500 ppm. *Helicoverpa armigera,* a polyphagous pest, has decreased its feeding activity (to 70.57%) by using a 2% hexane extract of seed (Sivaraman *et al.* 2014). *Radopholus similis*, a burrowing worm, is resistant to the nematicidal effects of aqueous leaf extract at 200 ppm (Pervez *et al.* 2011, Mukesh *et al.* 2012). Teak leaf skeletonizer eutectona was significantly inhibited by leaf extracts of SNV at 5% and 10%. (Sree *et al.* 2008, Patel *et al.* 2017)

Effect of SNV against inflammation and analgesic

Investigations into the key SNV alkaloids brucine and brucine N-anti-inflammatory oxide's effect revealed that both central and peripheral pathways are implicated in the anti-inflammatory activity. It was shown that the anti-inflammatory mechanism involves inhibition of prostaglandin E2 (PGE2) and elevated level of 5-hydroxytryindole-3-acetic acid (5-HIAA) (Khare and Atri 1997) Sandhika, an Ayurveda formulation including SNV, was tested for its anti-inflammatory effects in rats, and it was discovered to have considerable anti-inflammatory effects as well as extra protection against lipid peroxidation. The tail-pressure, hotplate, and writhing tests were used to examine the antinociceptive properties of the crude alkaloid fractions of SNV and the impact of different processing procedures on antinociception. In comparison to untreated samples, SNV treated with sand, licorice, oil, and vinegar had greater antinociceptive potential (Patel *et al.* 2017).

Effects of SNV on cardiovascular systems

An investigation into the impact of bhux (a poly-herbal formulation containing SNV) on diet-induced atherosclerosis in albino rabbits revealed that bhux is an effective multifactorial formulation against atherosclerosis in relation to intimal thickening, calcification, and collagen content (Tripathi *et al.* 2005, Patel *et al.* 2017)

Effects of SNV on central nervous system

Using the Y-maze, passive avoidance, and morris water maze tests on mice, the impact of loganin, one of the active components of SNV, on learning and memory deficits was examined. Memory impairment in terms of latency time was shown to have significantly improved in the group that received SNV treatment. Moreover, it dramatically reduced acetylcholinesterase activity in the frontal cortex and hippocampal regions (Kwon *et al.* 2009).

Effect of SNV against diabetes mellitus

In both healthy and diabetic rats induced with alloxan, the methanolic extract of SNV was tested for its anti-diabetic effects. The results revealed a dose-dependent relationship between increasing body weight and lower blood glucose levels. In the treated group compared to the control group, super oxide dismutase (SOD), catalase, and total protein levels rose, whereas lipid peroxidation, total cholesterol, serum creatinine, and blood urea nitrogen level decreased (Chitra *et al.* 2010, Patel *et al.* 2017).

Effects on the immune system

In animal studies, Nux vomica and its processed derivatives have some immunomodulatory effects. In a mouse investigation of delayed-type hypersensitivity, brucine (30 mg/kg) reduced the amount of ear swelling and slowed T lymphocyte proliferation, but it had no discernible impact on spleen and thymus indices (Wang *et al*. 2008).

Strychnos potatorum

Distribution and habitat

Nirmali is often found in tropical wet deciduous forests and scrub areas in the states of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Odisha, Madhya Pradesh, Chhattisgarh, and West Bengal. Also seen in open areas of India's agro-ecological Deccan Plateau, Eastern Ghats, Northern plains, Eastern plateau, Northern eastern highlands, and Eastern coastal plains. It thrives in the shade and grows well beneath the canopy of dominants. Since they are draught-registered, saplings and poles can tolerate seasonal draught (Mallikarjuna *et al.* 2007, Behera 2018).

Morphology and phenology

It is a medium sized deciduous tree having height up to 12 m. A slow growing small to medium sized to tree, easily recognizable with its oval/spreading canopy, crocodile bark, broadly ovate shining foliage with distinct nerves, small greenish to bluish black fruits (Schmelzer and Gurib-Fakim 2008). Flowering begins in April and lasts until the end of May, peaking in the three weeks between April and May. Fruits mature in around 7-8 months and typically contain 1-2 seeds (Mallikarjuna *et al.* 2007, Behera *et al.* 2018).

Phytochemical constituents

Diaboline and its acetate (Muthuthanthirige *et al.*

Table 2. Phytochemicals constituents of *Strychnos potatorum* (Behera 2018).

Plant part	Phytochemicals
Leaves	Alkaloids, glycosides, tannins, flavonoids, sterols, fats, oils, phenols and saponins
Stem bark	Alkaloids, flavonoids, sterols, glycosides, protein, amino acids, gums and mucilage
Flower	α-Pinene, Methyl chavicol, Mycrene, Bornyl acetate, Terpinyl acetate,1,8 Cineol, α-Borneol Nerol, β-Caryophllene, Linelyl acetate, d-Cadinene and d-Limonene
Fruit	Glycosides, carbohydrates, flavonoids, phenolic compounds and diterpenes
Seeds	Alkaloids: Diaboline, brucine, brucine Noxide, strychnine, strychnine N-oxide and pseudostrychnine, Vomicine, Icajine and novacine β-sitosterol, oleanolic acid, 3β-acetoxy oleanolic acid; flavonoids, sterols.
Root bark	Harmane carboxamide, Cantleyine, 18,19-Dihydrousambarensine, Polyneuridine, Norharmane, Akuammidine, Nor-C- Flurorocurarine, Ochrolifuanine-A, Bisnordihydrotoxiferine, Ochrolifuanine-E, Normacusine-B, Normavacurine, Henningsamine, 11-Methoxyhenningsamine, Dihydrolongi caudatine, Dihydrolongicaudatine Y, Antirhine, 20- Dihydroantirhine, 11-methoxy-12-hydroxydiaboline, Diaboline, 11-methoxydiaboline, Desacetylretuline and Diaboline N-oxide

2020) were found in phytochemical tests, along with brucine, loganin, mannose, sucrose, arachidonic, lignoceric, linoleic, oleic, palmitic, and stearic acids (Yadav *et al.* 2014) B-sitosterol, stigmasterol, oleanolic acid, its 3b acetate, saponins containing oleanic acid, galactose and mannose (seeds), triterpenes, and mannogalactans are all produced during the saponification of oil (Behera *et al.* 2018). Alkaloids, flavonoids, glycosides, phenols, saponins, sterols, and other secondary metabolites from Table 2 may all contribute to the therapeutic qualities of plants (Yadav *et al.* 2014).

Strychnos potatorum **pharmacological studies**

Anti-microbial activity

A few pathogenic gramme positive, gramme negative, and acid-fast bacteria and fungi were examined for their antibacterial potential using alkaloid fractions extracted from *Strychnos potatorum* Lf (Loganiaceae) seed. In the measured doses (100 and 200 g/mL), these fractions demonstrated notable antibacterial activity against both bacteria and fungus (Behera *et al.* 2018).

Anti inflammatory effect

Seeds were investigated in models of cotton pellet granuloma and hind paw edoema caused by carrageenin. The increasing amounts of lipid peroxide, acid phosphatases, and alkaline were found to be normalised by SPP and SPE, respectively. In acute and subacute inflammatory models, SPP and SPE both displayed dose-dependent anti-inflammatory action and these are similarly equivalent to those of the common medication of diclofenac sodium (Biswas *et al.* 2002, Yadav *et al.* 2014).

Anti diabetic activity

This species has anti-diabetic properties. In the animal treated with the extract, the amount of total serum protein also rose by up to 5 mg/ml. In addition, blood glucose levels decrease by 53%, illuminating the plant's potential as an antidiabetic (Adinolfi *et al.* 1994).

Diuretic activity

On treatment with *Strychnos potatorum* seed extract (SPSE), the number of cations in the urine increased in a dose-dependent manner. This result validates the diuretic properties of the *Strychnos potatorum* seeds used in traditional medicines (Yadav *et al.* 2014).

Antiulcerogenic

The aspirin plus pyloric ligation (Aspirin + PL)-induced stomach ulcer model to demonstrate the antiulcerogenic efficacy of *S. potatorum* Linn seeds to support its folklore claim. By reducing acid secretory activity and enhancing mucin activity in rats, the seed powder (SPP) and aqueous extract of the seeds (SPE) at two dosages of 100 and 200 mg/kg, po reduced the development of ulcers. According to the findings, SPP and SPE have antiulcerogenic properties through mucoprotective and antisecretory effects (Behera *et al.* 2018).

CONCLUSION

The medicinal plants *Strychnos potatorum* and *S. nux-vomica* are a rare source of many kinds of chemicals with varying chemical structures. As mentioned earlier, a variety of compounds have been isolated and identified from plants, including alkaloids, iridoid glycosides, flavonoid glycosides, triterpenoids, steroids, and organic acids. The development of new pharmaceuticals from these species should be prioritised for the control of various diseases since the worldwide scenario is currently shifting towards the use of non-toxic plant products with historic therapeutic uses. The chemistry of various components of these species has already been the subject of a sizable amount of research during the last few decades. For their better economic and therapeutic use, considerable research and development should be done on them and their products. Future studies should also emphasise bio-activity-guided separation methodologies.

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