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AN OVERVIEW OF BERBERIS ARISTATA: DRUG PROFILE, MORPHOLOGICAL ASPECTS, PHYTOCHEMISTRY AND PHARMACOLOGICAL ACTIVITIES

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ABSTRACT

Since ancient times, India's indigenous medical system has incorporated herbal plants as a customary origin of medication. India is recognized for its vast collection of medicinal plants, one of which is *Berberis aristata*, a member of the Berberidaceae family, primarily thrives in the sub- Himalayan region area and the Nilgiri Mountains in Southern India. *Berberis aristata* is utilized as a traditional remedy in multiple communities for addressing eye issues, hemorrhoids, bone density loss, arthritis, skin ailments, malaria, diarrhea, high temperature, allergic reactions, eye inflammation, metabolic issues, and in menopausal stages. The vegetation includes multiple phytochemical compounds, primarily alkaloids such as berberine, oxyberberine, and berbamine, aromoline, karachine, palmatine, oxyacanthine, and taxilamine. Berberine, the primary alkaloid, exists in roots, stem bark, rhizomes, and foliage, with the greatest concentration found in the roots. The pharmacological characteristics of Berberis aristata have been noted, including immunomodulatory and anti-inflammatory, antioxidant, anti-viral, anti-cancer, anti-microbial, liver- protective, kidney-protective and enhanced reproductive well-being. This review seeks to emphasize the phytochemistry and pharmacological characteristics of Berberis aristata that will provide information on the plant's medicinal uses Although more comprehensive clinical trials and studies at the molecular level will be necessary to completely comprehend and verify these attributes.

KEYWORDS: *Trigonella foenum-graecum*, fenugreek, phytochemistry, pharmacological activities, antidiabetic, antioxidant, saponins, diosgenin, 4-hydroxyisoleucine, traditional uses, functional foods, nutraceuticals.

INTRODUCTION

For millennia, diverse global cultures—including Indian Vaids and Unani Hakims—have utilized flora for their therapeutic benefits. Due to the adverse side effects, rising costs, and increasing antimicrobial resistance associated with synthetic allopathic drugs, there is a significant contemporary shift back toward botanical medicine. India, recognized as a vast hub of biodiversity, has integrated herbal remedies into its indigenous healing systems since antiquity.

As reported by the phytochemical studies conducted on Berberis aristata, this plant has been found to contain several types of yellow-coloured alkaloids. The alkaloids include berberine, oxyberberine, berbamine, aromoline, protoberberine alkaloid karachine, palmatine, oxycanthine, taxilamine, as well as tannins, sugar, and starch. This plant has demonstrated strong pharmacological effects, with considerable potential for continued research on its applications. This review will focus on the ethnobotany, pharmacognostic and pharmacological uses of ramie (Berberis aristata), an endangered species of therapeutic plant, which has gained attention in recent years due to its limited abundance and extensive usage in the pharmaceutical industry. There are multiple alternative herb-types on the market that may be used in place of Berberis aristata such as Berberis asiatica (Roxb.), Berberis lycium (Royle), Cosinium fenestratum (Gaertn.), and Morinda umbellatea (L). In Ayurvedic medicine, B. aristata is said to provide several medicinal uses such as: promoting perspiration and urination, tonifying, and being used in medicinal preparations for treating eye conditions, jaundice, skin ailments, diarrhea, syphilis, chronic rheumatism, and urinary illnesses. There are numerous references to the pharmacognostic and pharmacological properties of natural sources of daruharidra and other plants found to be used instead. In this literature review,

information on traditional medicinal properties and pharmacological studies on daruharidra, which is being listed on the red list of endangered herbal products, will be reviewed.

Seventy-five to eighty percent of the world's people rely on herbal medicine for most of their primary health care (especially developing nations), but only six percent of all plant species are studied for biologically active qualities, while only fifteen percent have been studied phytochemically. Thus, there is an urgent need to evaluate herbal medicines. Charaka and Susruta listed many different uses of herbs and their properties in treating a variety of ailments; they also used the term haridra dvaya (two haridras) when referring to haridra and daruharidra because of the similarities in their properties.

DRUG PROFILE AND TAXONOMICAL CLASSIFICATION OF Berberis aristata

- **Kingdom;** plantae
- **Division;** Magnoliophyta
- **Class;** Dicotyledonae
- **Family;** Berberidaceae
- **Genus;** Berberis
- **Species;** Berberis aristata DC.
- **Biological source;** It is obtained from dried root or root bark of Berberis aristata
- **Geographical source;** native to Himalayan region
- **Chemical constituents**; berberin, palmatine, barbamine, taxilamine
- **Scientific name;** Berberis aristata
- **Local name;** Daruharidra
- **Useful organ;** root, bark, flowers

MORPHOLOGICAL ASPECT

Berberis aristata (Daruhaldi) is essentially a large, erect, deciduous, spiny shrub (sometimes appearing almost evergreen in cooler, moist habitats) that typically attains a height of about 2–4 m, forming dense thickets on hill slopes. It has stout, straight stems with short internodes, giving a somewhat compact appearance.

The young twigs are white to pale yellowish brown and glabrous, while the older bark is pale brown externally

and deep yellow within, characteristically rough, deeply furrowed, and easily separable in longitudinal strips, which is an important diagnostic feature in crude drug identification. The stem is subterete to slightly angled, with short, sharp spines that are usually two- to three-fid near the base and solitary toward the apex, measuring about 1.5–5 cm in length; these spines are modified leaves and help protect the plant from grazing animals.

Leaves are arranged in small fascicles or tufts of about 3–8 at each node, often appearing clustered on dwarf shoots. They are obovate to oblanceolate-elliptic, typically 4–8 cm long and 2–3 cm broad, with a cuneate (gradually narrowed) base, entire or spinulose-toothed margins bearing small spinules, and an acute or obtuse apex with a short mucronate tip. The leaf texture is subcoriaceous, glossy and dark green on the upper surface, paler beneath, with 4–7 pairs of lateral veins that are sunken above and prominently raised on the lower side; the leaves are nearly sessile or borne on a very short petiole.

The plant bears yellow to greenish-yellow flowers, usually bisexual, arranged in subracemose, subumbellate or pseudoumbellate inflorescences that are about 5–6 cm long and carry 5–25 flowers per cluster; peduncles are 1–4 cm long and each flower is borne on a slender pedicel about 5–10 mm in length. Flowers measure roughly 10–14 mm across and possess small lanceolate to ovate bracts with acute tips, about 3 × 1 mm.

The perianth consists of six sepals in two whorls: an outer whorl of three smaller ovate-lanceolate sepals (about 2–3 × 0.8–1 mm) and an inner whorl of three larger obovate sepals that are clawed at the base and about 5–7 × 3–4 mm; inside these are six petals, obovate to oblong, 6–7 × 3–4 mm, with cuneate bases bearing a pair of nectarial glands, entire margins, and obtuse apices.

Stamens are arranged around the ovary, with filaments that may be sensitive and anthers that open by recurved valves. After flowering, the plant produces numerous ovoid, many-seeded berries that are initially green and become bright red, shining, and glabrous when ripe; these berries are acidic but edible, often relished by birds and sometimes used locally for making preserves or traditional preparations. Ecologically, B. aristata is commonly found in temperate and subtemperate Himalayan regions and adjoining hills, where it prefers well-drained, rocky or loamy soils, and its extensive root system, along with its spiny thickets, contributes to soil binding and protection against erosion.

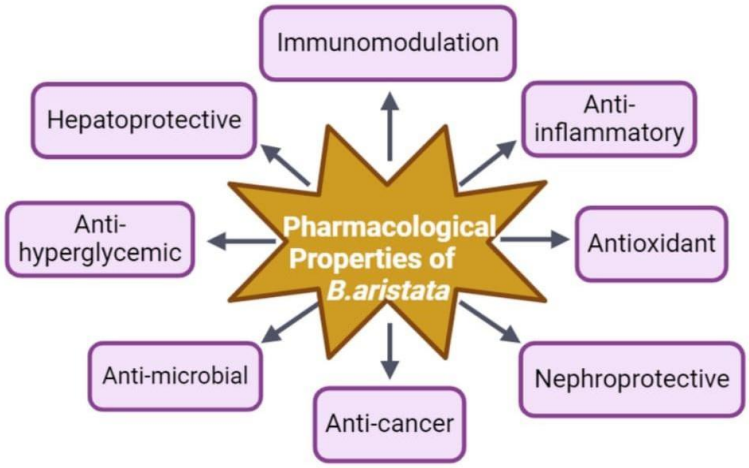
SYNONYMS OF FENUGREEK IN VARIOUS LANGUAGES

LANGUAGES	SYNONYMS
English	Indian Barberry
Hindi	Daruhaldi
Marathi	Daruharidra
Gujarati	Daru Haldar
Italian	Crespino aristato
German	Indische Berbeitze
Spanish	Agracejo indio
Arabian	Ameerbaarees

PHYTOCHEMISTRY OF BERBERIS ARISTATA

The berbamine, oxyacanthine, barberine, oxyberberine, karachine, palmatine contains aromoline and taxilamine. Berberis aristatacontains protoberberine and bis isoquinoline type of alkaloid. Root of plant Berberis aristata contains alkaloid which are berbamine, Berberine, oxycanthine, epiberberine, palmatine. dehydrocaroline, jatrorhizine and columbamine, karachine, dihyrokarachine, taximaline, oxyberberine, aromoline. Four alkaloids, pakistanine, methyl pakistanine, pseudopalmatine chloride and pseudoberberine chloride were also isolated from Berberis aristata.

PHARMACOLOGICAL ACTIVITIES



Anti-oxidant action

Oxidative stress, characterized by an imbalance between reactive oxygen species (ROS) production and antioxidant defenses, is widely recognized as a primary trigger for the onset and progression of numerous diseases, including chronic disorders, cardiovascular diseases, neurodegenerative conditions like Alzheimer's and Parkinson's, cancer, autoimmune disorders, cataracts, diabetes, arthritis, and aging-related pathologies. Various extracts of Berberis aristata (Daruhaldi) and its key alkaloid berberine have demonstrated robust antioxidant potential across multiple in vitro and in vivo models. For instance, a polyherbal ethanolic extract combining Berberis aristata, Nigella sativa, and Anethum sowa at 250 µg/ml exhibited strong antioxidant effects in H2O2, FRAP, and ABTS assays, achieving maximum inhibition rates of 82.56%, 83.77%, and 87.5%, respectively. The aqueous aril extract of Berberis aristata showed exceptional DPPH radical scavenging (99.29%), superoxide anion (O2- −) scavenging (99.94%), total antioxidant capacity (99.83%), and ferric reducing power (99.81%). Similarly, methanolic extracts displayed concentration-dependent DPPH and H2O2 scavenging, along with ferric ion reduction. Berberine itself inhibits nitric oxide (NO) production and inducible nitric oxide synthase (iNOS) expression in lipopolysaccharide (LPS)-stimulated murine macrophages in a dose-dependent manner. Polyherbal formulations incorporating Berberis aristata, as well as its hydroalcoholic extracts, significantly scavenged DPPH, ABTS, superoxide, and NO radicals. Berberis species broadly suppress thiobarbituric acid reactive substances (TBARS) formation, lower NO levels, inhibit DPPH oxidation, and enhance glutathione peroxidase (GPx) and superoxide dismutase (SOD) activities action.

Anti-microbial action

The aqueous aril extract of Berberis aristata at 500 µg/ml demonstrated potent in vitro antibacterial activity against Gram-positive bacteria such as Bacillus subtilis (10 mm zone of inhibition), Micrococcus luteus (12 mm), and Staphylococcus aureus (27 mm), as well as Gram-negative strains including Escherichia coli (24 mm) and Shigella flexneri (22 mm), proving comparably effective to standard antibiotics. Root and bark aqueous extracts further exhibited broad-spectrum antibacterial action with zones of inhibition spanning 12–25 mm across multiple pathogens, showing highest susceptibility in Klebsiella pneumoniae, followed by Staphylococcus aureus, MRSA, Salmonella typhimurium, and Staphylococcus epidermidis, while Enterococcus faecalis displayed the least sensitivity and certain strains like Klebsiella pneumoniae variant, Shigella flexneri, and Salmonella typhimurium were fully resistant. These extracts also induced cytotoxic effects on L20B, RD, and Hep2 cell lines, with IC50 values between 245–473 µg/ml. Notably, berberine isolated from the methanolic stem extract potently targeted drug-resistant Helicobacter pylori from gastroesophageal reflux disease patients (untreated with prior antimicrobials), achieving efficacy at an ultralow concentration of 0.000075 µg/ml, suggesting its utility in managing H. pylori-mediated ulcers. The root aqueous extract displayed promising antiplasmodial effects against Plasmodium berghei NK-65 in vitro (IC50 40 µg/ml) and in Plasmodium-infected BALB/c mice, yielding dose-dependent chemosuppression up to 67.1% at 350 mg/kg/day, alongside 53.9% preventive activity and extended.

Anti-hyperglycaemic effect

In alloxan-induced diabetic rats, the ethanolic root extract of Berberis aristata significantly reduced body weight and fasting blood glucose levels, demonstrating potent antidiabetic effects at doses of 50 mg/kg and 100 mg/kg body weight, with glucose reductions of 63.01% and 66.27% respectively compared to diabetic controls. Treatment with the extract also normalized serum lipid profiles by significantly lowering total cholesterol and triglycerides, while markedly decreasing elevated levels of liver enzymes alanine aminotransferase (ALT) and aspartate aminotransferase (AST), alongside restoring kidney function markers such as blood urea nitrogen (BUN) and serum creatinine to near- normal ranges.

The observed antidiabetic efficacy is largely attributed to dipeptidyl peptidase-IV (DPP-IV) inhibition, as evidenced by the methanolic extract's IC50 value of 14.46 µg/ml (compared to standard Diprotin A at 1.543 µg/ml). Furthermore, the aqueous extract exhibited robust hypoglycemic potential in vitro by enhancing glucose adsorption, inhibiting glucose diffusion into external solutions during amylolysis kinetic assays, and promoting glucose uptake by yeast cells, collectively underscoring Berberis aristata's multifaceted mechanisms in managing hyperglycemia, dyslipidemia, and diabetic complications.

Anti-carcinogenic action

Berberine, the predominant isoquinoline alkaloid in Berberis aristata and other Berberis species, exhibits potent anticancer activity through multiple mechanisms including apoptosis induction, cell cycle arrest, DNA intercalation, and inhibition of tumor proliferation, metastasis, and protein biosynthesis. In prostate cancer cell lines, berberine triggers G0/G1 phase arrest and downregulates p53-dependent regulatory proteins in both p53-expressing LNCaP and p53-null PC-3 cells. It demonstrates cytotoxicity against murine melanoma B16 cells, human monocytic leukemia U937 cells, and selectively targets mitochondria in K1735-M2 melanoma cells.

The methanolic stem extract of Berberis aristata effectively inhibits human breast cancer MCF-7 cell proliferation by suppressing DNA synthesis, activating apoptotic pathways, and preventing metastasis; at 400 mg/kg in vivo, it significantly reduces tumor burden in DMBA-induced mouse models while normalizing hemoglobin and red blood cell counts. Berberine doses

of 0.5–5 mg/kg markedly lower tumor incidence in 20-methylcholanthrene or N-nitrosodiethylamine-induced carcinogenesis in mice, with a 200 µg/ml extract showing 32.81% cytotoxicity against HeLa cells (IC50 118.97 µg/ml).

Its planar quaternary ammonium structure facilitates DNA intercalation and blocks topoisomerase activity, contributing to broad-spectrum effects observed in polyherbal formulations containing Berberis aristata, which yield IC50 values around 182 µg/ml against MCF-7 cells in MTT assays. Additional studies confirm berberine's efficacy in ovarian, colon, and hepatocellular carcinoma models via NF-κB inhibition, ROS modulation, and angiogenesis suppression, alongside Berberis aristata root extracts enhancing chemotherapeutic outcomes by mitigating multidrug resistance through P-glycoprotein inhibition, collectively positioning the plant as a promising adjunct in oncology for its multi-targeted antiproliferative, proapoptotic, and chemosensitizing properties.

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