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REVIEW ARTICLE

Medicinal Potential of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and *Habenaria diphylla* (Nimmo) Dalzell: A Review of Ethnobotany, Phytochemistry, Pharmacology, and Therapeutic Prospects

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ABSTRACT

Herminium edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and *Habenaria diphylla* (Nimmo) Dalzell are terrestrial tuberous orchids of the genus *Habenaria* (Orchidaceae) that have been used in South Asian traditional medicine for centuries as ingredients of the *Rasayana* (rejuvenating) drugs called *Ashtavarga*, e.g., *Chyawanprash*. Due to increased collection, slow growth, limited distribution, and taxonomical intricacies, both species are considered critically important for conservation and have attracted considerable scientific interest. This review aims to provide an updated overview of the botany, ethnopharmacology, phytochemistry, and pharmacology of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and, where applicable, extrapolate the knowledge to *Habenaria diphylla* (Nimmo) Dalzell. For the latter species, the review focuses primarily on the botany, ethnopharmacology, and phytochemistry, as well as the pharmacology of related Habenaria species (*Habenaria intermedia* D.Don, *Habenaria digitata* Lindl., *Habenaria aitchisonii* Rchb.f.). The tubers of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang were found to contain phenolic acids (gallic acid, p-coumaric acid, hydroxybenzoic acid), flavonoids, coumarins (e.g., scopoletin), stilbenoids/bibenzyls (batatasin III), triterpenoids, and taxane-type diterpenoids. The pharmacology of this species is predominantly supported by *in vitro* and *in vivo* studies that demonstrate antioxidant, immunomodulatory, hepatoprotective, anti-inflammatory, and antimicrobial effects. In contrast, there is a lack of phytochemical and pharmacological data on *Habenaria diphylla* (Nimmo) Dalzell. Therefore, the discussion on this species is largely based on extrapolation from related plants of the genus *Habenaria*. Particular attention is drawn to the taxonomical complexities of the *Ashtavarga* drugs "*Riddhi*" and "*Vriddhi*" and the need for conservation and further research on both species. The review highlights the promising therapeutic potential of the two orchid species, as well as the necessity to address the gaps in taxonomy, phytochemistry, pharmacology, standardization, and cultivation before their medicinal properties can be fully harnessed.

1. INTRODUCTION

The Orchidaceae family, which includes more than 25000 species, is one of the largest angiosperm groups. It has made a major contribution to the folk medicine of Asia, Africa, and Latin America, where various parts of these plants have been used as tonics, aphrodisiacs, antipyretics, and healing agents.[1,2]. Within this family, the genus Habenaria Wild. comprises several hundred species of terrestrial, tuberous herbs, ranging from the Himalaya to sub-Saharan Africa and Southeast Asia. A number of Himalayan species of Habenaria possess pharmacognostic interest, being regarded as the drug of the *Ashtavarga* ("group of eight"), one of the *Rasayana* (rejuvenative) drugs mentioned in the classical *Ayurveda* literature, used in the preparation of polyherbal tonic *Chyawanprash*.[3]

The two species of orchid which are most frequently mentioned in this context are *Herminium edgeworthii* (Hook.f. ex Collett) X.H.

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Jin, Schuit., Raskoti and Lu Q. and *Habenaria diphylla* (Nimmo) Dalzell. Both are cold-adapted, high-altitude terrestrial orchids, which possess ovoid to fusiform, subterranean tuberoids, which are the actual source of the officinal drug. While *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. has been the focus of botanical and pharmacological research in Indian scientific institutions for the last two decades, as it is one of the constituents of the *Ashtavarga* formulations,[4,5] *Habenaria diphylla* (Nimmo) Dalzell is a poorly known species which has been scarcely studied and, despite being well characterized at the taxonomic level, has few if any reports of phytochemical and pharmacological investigations in the scientific literature; a situation which is the subject of this review.

1.1. Aims and Objectives

1.1.1. Aim

To critically review and consolidate the existing knowledge on the ethnobotany, phytochemistry, and pharmacology of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and *Habenaria diphylla* (Nimmo) Dalzell, two *Ashtavarga* orchids used in *Ayurvedic Rasayana* formulations and to identify the gaps limiting their therapeutic development.

1.1.2. Objectives

1 To compile the taxonomic, botanical, and conservation status of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and *Habenaria diphylla* (Nimmo) Dalzell, including clarification of the "*Riddhi-Vriddhi*" nomenclatural confusion and common market adulterants.
2 To document the traditional/ethnobotanical uses of these species within the *Ashtavarga* group and classical *Ayurvedic Rasayana* context.
3 To summarize the phytochemical constituents (phenolic acids, flavonoids, coumarins, stilbenoids, triterpenoids, taxane-type diterpenoids) reported from *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang tubers, and to extrapolate this to *Habenaria diphylla* (Nimmo) Dalzell via related Habenaria species where direct data are absent.
4 To review the pharmacological evidence (antioxidant, immunomodulatory, hepatoprotective, anti-inflammatory, antimicrobial, adaptogenic/central nervous system [CNS] activities) available for *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang and congeneric species.
5 To evaluate conservation threats and sustainable utilization strategies (*in vitro* propagation) for both species.
6 To identify research gaps and outline future directions for standardization, safety pharmacology, and eventual clinical translation.

2. MATERIALS AND METHODS

2.1. Study Design

Narrative review of published literature on *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. Huang (syn. *Habenaria edgeworthii* Hook.f. ex Collett) and *Habenaria diphylla* (Nimmo) Dalzell, extrapolating to related species (*Habenaria intermedia* D.Don, *Habenaria digitata* Lindl., *Habenaria aitchisonii* Rchb.f.) where direct data on the target species were unavailable.

2.2. Data Sources

Peer-reviewed journals, book chapters (e.g., Immunity Boosting Medicinal Plants of the Western Himalayas), and specialized botanical databases (e.g., orchidspecies.com, Selina Wamucii, POWO).

2.3. Search Strategy

Literature searches using combinations of terms such as "*Habenaria edgeworthii*," "*Herminium edgeworthii*," "*Habenaria diphylla*," "*Ashtavarga*," "*Riddhi*," "*Vriddhi*," "Orchidaceae medicinal," "*Rasayana*," and related pharmacological/phytochemical keywords (antioxidant, hepatoprotective, immunomodulatory, anti-inflammatory).

2.4. Inclusion Criteria

Studies reporting botanical description, ethnobotanical use, phytochemical isolation or characterization, *in vitro* and *in vivo* pharmacological evaluation, or conservation status of the target species or their close congeners.

2.5. Exclusion Criteria

Sources referring to the taxonomically distinct African species also marketed under the name "*Habenaria diphylla*," unless explicitly discussed for comparative or clarification purposes.

2.6. Data Extraction and Synthesis

Information organized thematically into taxonomy or nomenclature, ethnobotany, phytochemistry, pharmacology, conservation status, and future research directions; findings from related species clearly flagged as extrapolated rather than direct evidence.

3. TAXONOMIC AND BOTANICAL OVERVIEW

3.1. Nomenclatural Note: "*Riddhi*" and "*Vriddhi*"

A perennial challenge in this field has been that the *Ayurvedic* names *Riddhi* and *Vriddhi* have been associated with different species of the genus *Habenaria* by different authors. Several pharmacognostic references identify Riddhi as *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. (*Platanthera edgeworthii* (Hook.f. ex Collett) R.K.Gupta) and Vriddhi as *Habenaria intermedia* D.Don,[1] whereas other regional ethnobotanical accounts reverse this assignment.[6,7] This inconsistency, compounded by widespread market adulteration with morphologically similar tubers (including *Dactylorhiza hatagirea* (D.Don) Soó and various *Asparagus* and *Dioscorea* species used as substitutes),[8] means that pharmacological claims attached to "*Riddhi*" or "*Vriddhi*" in the older *Ayurvedic* and market literature should be interpreted with caution unless the botanical source has been voucher verified. Readers of this review should therefore treat vernacular *Ashtavarga* nomenclature as a starting point for literature searching rather than as definitive species identification [Figures 1 and 2].

3.2. *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q.

Herminium edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. is a perennial herb growing to 0.5 m tall, with minute sessile tuberoids, leafy and somewhat flexuous stem with three to four sheathing leaves, and cylindrical inflorescence of yellowish green, deflexed flowers.[9] It is distributed in the east and west Himalayas, Nepal, Pakistan, and Tibet; it grows on grassy slopes, open pastures, and edges of oak forests at an altitude of 1800–3000 m. Tubers are harvested in autumn (October–November) after fungicide-treated propagation stock is planted in spring (May), a cultivation cycle that reflects the species' slow, seasonally constrained regeneration.

3.3. *Habenaria diphylla* (Nimmo) Dalzell

Habenaria diphylla (Nimmo) Dalzell is a small, sometimes minute, cold-growing terrestrial orchid, with ovoid fusiform tubers, an erect, sheathed stem, usually a single, narrow elliptic oblong leaf, and a lax 4–6 flowered inflorescence of narrowly campanulate white flowers. The species is distributed throughout China, India, Bangladesh, the eastern Himalaya, Nepal, Myanmar, Thailand, and the Philippines, usually on open grassy subalpine slopes between 3,300 and 4,900 m,[6] generally higher and more restricted in habitat than *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. It should be noted that horticultural and trade sources occasionally use the binomial "*Habenaria diphylla* (Nimmo) Dalzell" to refer to a related but distinct African terrestrial orchid species used in traditional medicine for topical application and treatment of fever;[10] the taxonomic relationship between this African material and the Asian *Habenaria diphylla* (Nimmo) Dalzell described here is unresolved in the sources available for this review, and the two should not be considered pharmacologically equivalent. Further, this review concentrates on the Himalayan/Asian taxon, which is the ethnobotanical entity of *Ashtavarga* rather than any African material.

4. ETHNOBOTANY AND TRADITIONAL USES

4.1. The Ashtavarga Context

The *Ashtavarga* consists of eight herbs, including *Kakoli, Kshirakakoli, Meda, Mahameda, Jivaka, Rishbhaka, Riddhi,* and *Vriddhi* belonging to the families of Orchidaceae, Liliaceae, Zingiberaceae and related taxa, which are considered in *Ayurveda* as *Rasayana* (rejuvenating) drugs. As a group, *Ashtavarga* plants are indicated for sexual and reproductive problems, general weakness, pain, and immunity, and they are major components of drugs such as *Chyawanprash, Ashtavarga churna, Brimhanigutika,* and *Vajikara ghrita*. The orchidal plants, including *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q., have been mentioned by *Ayurveda dravyaguna vigyana* as nerve and heart tonic, blood purifier or antidote for blood-related infections, febrifuge, antitussive, and remedy for muscular pain, sprains, arthritis and gout, as well as aphrodisiac, depurative, and anthelmintic properties attributed to the group more broadly.[11]

4.2. Documented Folk and Regional Uses of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q.

Beyond classical *Ayurveda*, tubers of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and its congener *Habenaria intermedia* D.Don are described in regional Himalayan practice as a brain tonic, appetizer, and immunity booster and as a general "blood purifier".[12] The plant is known by the vernacular name *Riddhi* in Hindi, Kannada, Malayalam, Tamil, and Telugu, indicating a wide geographic reach of its use within the Indian subcontinent despite its narrow ecological distribution. Vernacular Sanskrit synonyms recorded for the *Ashtavarga* orchid include *Lakshmi, Mangala, Rathanga, Rishisrishta, Saravajanpriya, Siddhi, Sukha, Vasu, and Yuga*, underscoring the plant's longstanding cultural association with vitality, auspiciousness, and rejuvenation. The tubers are traditionally described as sweet-tasting and emollient and are used as a general and reproductive tonic and as an anthelmintic.

4.3. Ethnobotanical Status of *Habenaria diphylla* (Nimmo) Dalzell

Species-specific ethnobotanical documentation for the Asian *Habenaria diphylla* (Nimmo) Dalzell is sparse in the accessible literature; its use appears to be subsumed within broader regional accounts of medicinal Himalayan orchids rather than documented as a distinct entry. This scarcity of primary ethnobotanical field data is itself a notable gap: Given the species' overlapping habitat and morphological similarity to other Ashtavarga associated *Habenaria* taxa, it is plausible that *Habenaria diphylla* (Nimmo) Dalzell tubers are collected, traded, and used interchangeably with those of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and *Habenaria intermedia* D.Don in some source regions, but this hypothesis requires field verification through ethnobotanical surveys with voucher specimen identification before it can be treated as established fact.

5. PHYTOCHEMISTRY

5.1. *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q.

Qualitative and quantitative phytochemical screening of *Herminium* edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. tubers has identified several major classes of secondary metabolites, broadly mirroring those reported for the congeneric and taxonomically confusable *Habenaria intermedia* D.Don:

- Phenolic acids and derivatives: Gallic acid, p-coumaric acid, and hydroxybenzoic acid have been reported from tuber extracts, together contributing substantially to measured total phenolic content.[13,14]
- Coumarins: Scopoletin is a recurrent marker compound isolated from ethyl acetate fractions of Ashtavarga Habenaria tubers.[15]
- Flavonoids and Tannins: Present qualitatively across populations, with total flavonoid content varying significantly between geographically distinct populations
- Stilbenoids/bibenzyl derivatives: Batatasin III and related bibenzyl compounds have been isolated from tuber extracts of the genus
- Sterols and fatty acids: β-sitosterol and linoleic acid have been reported
- Other constituents: Loroglossol (an orchid-characteristic glucoside), catechin, sinapic acid, and reports of taxane-type compounds (taxol) have also been documented from Ashtavarga Habenaria material, although the taxol reports in particular warrant confirmation by modern spectroscopic and chromatographic methods given the pharmaceutical significance such a finding would carry A series of population level studies on the variations of total content of phenolics and flavonoids associated with antioxidant potential revealed significant differences between wild *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. populations on the west Himalaya. With regard to the genetic differentiation, the ISSR analysis demonstrated only partial correlation with observed biochemical variations 4. From this, it could be postulated that both genotype and habitat-specific environmental variables (including such factors as altitude, soil composition, and microclimate) contribute to the overall content of pharmaceutically active metabolites in wild-harvested tubers of this species, which has important implications for the standardization of any future phytopharmaceutical preparations.

5.2. *Habenaria diphylla* (Nimmo) Dalzell

No dedicated phytochemical profiling of Asian *Habenaria diphylla* (Nimmo) Dalzell tubers was identified in the literature surveyed for this review. In the absence of direct data, cautious inference can be drawn from (i) the general phytochemical signature of the genus *Habenaria*, which across multiple species consistently yields phenolics, flavonoids, bibenzyls/stilbenoids, coumarins and, in some

species, alkaloids and triterpenoids[16] and (ii) the close taxonomic and ecological relationship of *Habenaria diphylla (Nimmo) Dalzell* to *Herminium* edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. This is an inference, not a substitute for direct analytical work, and represents the single largest evidence gap identified in this review.

6. PHARMACOLOGICAL ACTIVITIES

6.1. Antioxidant Activity

In vitro antioxidant assays (1,1-diphenyl-2-picrylhydrazyl [DPPH] and 2,2'-azino-bis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS) radical scavenging and ferric reducing antioxidant power, ferric reducing antioxidant power) applied to *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. tuber extracts have demonstrated measurable free radical scavenging capacity that correlates with total phenolic and flavonoid content across wild populations. Related *Ashtavarga* species have similarly shown oxidative-DNA-damage-protective activity attributed to their phenolic fraction. Reported DPPH inhibition for tuber extracts has been described as moderate rather than exceptional relative to well-characterized antioxidant botanicals, indicating that antioxidant activity, while real and reproducible, may not by itself be the species' most distinctive pharmacological property.

6.2. Immunomodulatory Activity

The ethanolic extract of tuber of closely related species *Habenaria intermedia* D.Don was evaluated for its immunostimulant activity in Swiss albino mice by carbon clearance assay, delayed type hypersensitivity response, and hematological parameters,[14,17] supporting the traditional *Ashtavarga* reputation as an "immunity booster." More recently still, targeted phytochemical studies have begun identifying immunomodulatory constituents in *Habenaria intermedia* D.Don extracts with activity in the NLRP3 inflammasome pathway, isolated and characterized by high-performance liquid chromatography photo diode array (HPLC-PDA) and nuclear magnetic resonance (NMR) as well as mass-spectrometric analysis.[18] Because *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. shares habitat, traditional indication and a substantially overlapping phytochemical profile with *Habenaria intermedia* D.Don, these findings provide a strong pharmacological rationale for testing *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. extracts directly in comparable assays, though direct confirmatory studies in *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. itself remain limited.

6.3. Hepatoprotective Activity

Tuber extracts and isolated secondary metabolites of *Habenaria intermedia* D.Don showed protective effect against carbon tetrachloride-induced liver damage in rats by reversing the impaired biochemical functions of the liver.[19] This activity is consistent with the claimed traditional use of *Ashtavarga* orchids as blood purifiers and general tonics, and, by virtue of shared phenolics and flavonoids with *Habenaria intermedia* D.Don, represents another activity that may also be present in *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q.

6.4. Anti-inflammatory and Antinociceptive Activity

In terms of providing a solid foundation of evidence, there is no information about the anti-inflammatory properties of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. However, the congeneric species provide a reasonable basis for supporting the proposed effect, as evidenced by the data about *Habenaria digitata* Lindl. Active compounds isolated from this plant have demonstrated antioxidant and anti-inflammatory activity *in vitro*, *in silico*, and *in vivo*. The mechanism involves the inhibition of cyclooxygenase (COX)-1/2 and 5-Lipoxygenase (LOX) pathways as well as regulation of superoxide dismutase, catalase, glutathione peroxidase, and malondialdehyde in the brain, heart, and liver in the mouse model of pleurisy induced by carrageenan.[20] *Habenaria aitchisonii* Rchb.f. chloroform and ethyl acetate fractions produced antinociceptive effects exceeding a standard analgesic in acetic-acid and formalin tests and anti-inflammatory effects in carrageenan-induced paw edema mediated via COX-2 and 5-LOX inhibition, with no observed toxicity at oral doses up to 3,000 mg/kg.[21] These congeneric findings, together with the traditional indication of *Ashtavarga* orchids for muscular pain, sprains, arthritis, and gout,[1] justify prioritizing anti-inflammatory and analgesic screening of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and *Habenaria diphylla* (Nimmo) Dalzell extracts in future work.

6.5. Antimicrobial and Antifungal Activity

Antibacterial and antimicrobial activity has been reported among the secondary metabolites common to *Ashtavarga* Habenaria tubers. Separately, traditional use of (the botanically distinct, Africa associated) material referred to as "*Habenaria diphylla* (Nimmo) Dalzell" for skin disease and as an antifungal agent has been recorded in ethnobotanical trade sources, a use-pattern consistent with, but not proof of, antimicrobial bioactivity in the Asian taxon discussed in this review; this parallel should be treated as hypothesis-generating only.

6.6. Adaptogenic, CNS and Other Reported Effects

Ashtavarga Habenaria species, including *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q., have been described in review literature as possessing antistress, anti-anxiety, and general "tonic" or adaptogenic properties consistent with their traditional classification as *Rasayana* and nerve/cardiac tonics. These descriptors appear consistently across secondary and tertiary sources but are, in the material reviewed here, seldom traced back to a specific, method-described primary pharmacological study for *Herminium* edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. itself; they should therefore be read as traditional/reputational claims pending rigorous experimental confirmation (e.g., validated rodent models of stress, anxiolysis and cognition, with appropriate positive controls and dose response data).

7. CONSERVATION STATUS AND SUSTAINABLE UTILISATION

Both species face conservation pressure. *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. is explicitly described as a threatened medicinal orchid of the west Himalaya, with rarity compounded by increasing commercial demand for *Ashtavarga* raw drug, slow and technically demanding propagation, narrow altitudinal and habitat range, and the general vulnerability of Himalayan terrestrial orchids to habitat degradation, deforestation, and forest fires. Because botanical identity is frequently uncertain in trade with genuine Riddhi/*Vriddhi* material commonly substituted or adulterated by morphologically similar tubers of *Dactylorhiza hatagirea* (D.Don) Soó, *Dioscorea bulbifera* L., *Asparagus filicinus* Buch.-Ham. ex D.Don and *Sida acuta* Burm.f. Sustainable supply strategies must be paired with pharmacognostic

authentication (macroscopic, microscopic and molecular) to ensure that pharmacological and clinical claims are anchored to correctly identified plant material. *In vitro* propagation protocols using plant growth regulators such as meta-topolin, thidiazuron and chitosan have been reported for *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and related medicinal orchids as a route to reduce wild harvest pressure while supplying material of consistent genetic and phytochemical quality for research and formulation.[22] No conservation-specific literature on *Habenaria diphylla* (Nimmo) Dalzell was identified, which is itself concerning given its narrower, higher altitude habitat range compared with *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q.[23]

8. THERAPEUTIC PROSPECTS AND FUTURE RESEARCH DIRECTIONS

- Compound isolation and structural confirmation: Modern chromatographic and spectroscopic (HPLC-PDA, LC-MS, NMR) characterization of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. tubers, following the precedent set for H. intermedia, to establish a reliable marker compound and fingerprint profile.
- Direct pharmacological evaluation of H. diphylla: *In vitro* antioxidant, anti-inflammatory and antimicrobial screening, followed by *in vivo* studies, using voucher-authenticated Asian *Habenaria diphylla* (Nimmo) Dalzell material specifically, rather than extrapolation from congeners or from the taxonomically distinct African taxon carrying the same binomial.
- Mechanistic and target-based studies: Building on NLRP3-inflammasome and COX/5-LOX pathway work already reported for congeneric *Habenaria* species, to define the molecular basis of anti-inflammatory and immunomodulatory activity.
- Toxicology and safety pharmacology: Acute and subchronic toxicity studies specific to *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and *Habenaria diphylla* (Nimmo) Dalzell extracts, given that most existing safety data derive from other *Habenaria* species.
- Standardization and quality control: Development of macroscopic, microscopic, chromatographic, and DNA-barcoding methods to distinguish genuine tubers from common market adulterants and substitutes.
- Sustainable supply chains: Scale-up of tissue-culture and controlled cultivation protocols to relieve wild-harvest pressure while preserving the chemotypic diversity associated with pharmacological activity.
- Clinical translation: Well-designed, ethics-approved human studies would only be appropriate after the above preclinical and quality control foundations are established; no clinical trial data for either species were identified in this review.

9. DISCUSSION

- Taxonomic and nomenclatural ambiguity - The unresolved *Riddhi/Vriddhi* assignment across sources and its consequences for interpreting older pharmacological literature.
- Market adulteration - Substitution of genuine tubers with *Dactylorhiza hatagirea*, *Asparagus*, *Dioscorea*, and *Sida acuta*, and the need for pharmacognostic (macroscopic, microscopic, molecular) authentication.
- Phytochemical profile versus pharmacological correlation - How phenolics, flavonoids, coumarins (scopoletin), and bibenzyls (batatasin III) correlate with antioxidant activity across wild populations, and the influence of genotype versus habitat (altitude, soil, microclimate).
- Evidence asymmetry between the two species - *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. has a growing evidence base, while *Habenaria diphylla* (Nimmo) Dalzell remains almost entirely unstudied, with current claims resting on extrapolation from congeners (*Habenaria intermedia* D.Don, *Habenaria digitata* Lindl., *Habenaria aitchisonii* Rchb.f.).
- Mechanistic gaps in pharmacology - Promising leads (e.g., NLRP3 inflammasome modulation, COX-1/2 and 5-LOX inhibition) demonstrated in related species but not yet confirmed directly in *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. or *Habenaria diphylla* (Nimmo) Dalzell.
- Conservation versus commercial demand - Slow growth, narrow habitat range, and rising demand for *Ashtavarga* raw drugs, weighed against emerging tissue culture or micropropagation solutions.
- Translational research gaps - Absence of toxicology, standardization or quality control methods, and clinical trial data, and what would be needed before these species could move toward validated therapeutic products.

10. CONCLUSION

Herminium edgeworthii (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. and *Habenaria diphylla* (Nimmo) Dalzell belong to the *Ashtavarga* group of *Ayurvedic Rasayana* herbs; the former has documented evidence on the pharmacology of its tubers while the latter one has been the subject of limited research. The scientific evidence on the biological activity of *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q. is steadily growing, with reports on the presence of antioxidant phenolic compounds and reasonable extrapolation of the active ingredients and mechanisms of action from a closely related species *Habenaria intermedia* D.Don. For the counterpart herb, *Habenaria diphylla* (Nimmo) Dalzell, no substantial pharmacological evidence has been found, and there are no reasons to believe that its biological activity, if any, substantially differs from the rest of the genus. To fully benefit from the centuries-old ethnomedical experience with these plants, it is necessary to perform voucher specimen-based phytochemical analyses, pharmacological assays, develop quality control methodologies, and establish sustainable cultivation practices to reduce the pressure on the wild populations.

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16. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

17. DISCLAIMER/VIEW AND OPINIONS

The opinions expressed in this article are solely those of the authors and do not reflect the views of the International Research Journal of Ayurveda and Yoga or its editorial board.

18. AI-USE DECLARATION

The authors declare that no generative AI tools were used to create scientific content, interpret data, or draft any sections of this manuscript. AI-based tools were used solely for minor language and grammar refinements to improve clarity and readability. All scientific content, analysis, and conclusions remain the sole responsibility of the author.

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Figure 1: *Herminium edgeworthii* (Hook.f. ex Collett) X.H. Jin, Schuit., Raskoti and Lu Q

Figure 2: Habenaria diphylla (Nimmo) Dalzell