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ORIGINAL RESEARCH ARTICLE

Alternates of the Medicinal and Aromatic Plants for Future Industrial Demand, Development, and Conceivable Conservation

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ABSTRACT

Introduction: Natural habitats of the medicinal and aromatic plants (MAPs) are declining due to unsustainable collection, high demand, and high volume and continuous supply of the raw materials, and most recently due to global and regional climatic changes. Hence, there is a high need to alternate the original species in terms of plants and plant part use.

Materials and Methods: Alternatives/substitution of an Ayurvedic, genuine, and grantha based, as per Ayurvedic Pharmacopoeia of India species are studied and analyzed with taxonomical and phytochemicals points of view such as *Rasa, Guna, Veerya, Vipaka,* and *Prabhava* versus species, genus, family, and order along with bioactive chemical markers.

Results and Discussion: Some of the RET, MAPs are belong to monotypic genus and some are also belong to IUCN red list category: *Aconitum chasmanthum* Stapf. ex Holmes, *Aegle marmelos* L., *Aquilaria agallocha* Roxb., *Berberis aristata* DC., *Cissampelos pareira* L., *Commiphora wightii* (Arnott) Bhandari, *Embelia ribes* (Burm.) F., *Gmelina arborea* Roxb., *Hemidesmus indicus* (L.) R. Br., *Hydnocarpus kurzii* (King) Warb, *Nardostachys grandiflora* Wall. ex DC., *Oroxylum indicum* (L.) Kurz, *Picrorhiza kurrooa* Royle, *Pterocarpus santalinus* L. f., *Saraca asoca* (Roxb.) Wild, *Stereospermum suaveolens* (Roxb.) DC, *Swertia chirayita* (Roxb. ex Flem.) Karst and *Tecomella undulata* (Sm.) Seems has been suggested for possible alternates with the plants and plant part use. Selection of substitution may be regional or disease-wise in particular but in general whole plants substitution required comprehensive study on botanical aspects, active phytoconstituents, biological active markers, and pharmacological activity.

1. INTRODUCTION

Medicinal and aromatic plants (MAPs) are the important commodity of secondary metabolites for life-saving drugs next to primary metabolites.[1] MAPs are disappearing now from the wild habitats as well as some of the domestic/cultivated sources due to unsustainable collection and lack of interest.[2,3] Global warming, local climatic conditions, and natural disasters of native habitats due to human interference and without mitigation plan may be the reason.[4] Endemic MAPs are confined to some districts, state, and accordingly phytogeography of the natural or manmade habitats.[5] Threatened MAPs will be affected in terms of the local population[6,7] but when till the globally distributed plant species will be available in the form of raw drugs/raw material (RM) for the industrial development. Availability in due time, higher price of the RM, regulations, and quality compliances with some other issues are now important industrial concern for the text referred species versus alternative plants.

Alternates provide a great scope for physicians to utilize drugs/RMs that are easily not available in the native places and those are cost-effective and better suitable for the user in view of body phenotypes, most appropriate for the management of the disease as and when required on the urgent basis.[8] Substitution of the herbs has achieved many goals through the basic idea which was given by the ancient Ayurveda based on *Rasa* (taste), *Guna* (nature), *Veerya* (potency), *Vipaka* (results), and *Prabhava* (action). Ancient *Acharyas* were very firm about taking substitute drugs in place of the text referred on basis

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of physical appearances and biological actions that were only possible due to their proper knowledge of identification of the raw drugs. Rathore and Bhagat[8] have also stated that the most essential criteria for substitution are pharmacological activity/bioequivalence of the selected drugs than morphology and resemblance of phytochemicals as believed by modern science. Meanwhile, analysis of the herbs/drugs has largely depended on reliable methods for correct botanical identification, standardization, and quality assurance.[6,9]

At present, an alternative of the herbal drugs is a burning issue for acceptance by the modern scientific community.[10] The most common problem involving MAPs stating materials is the intentional or unintentional replacement due to multiple reasons such as unavailability of the RMs, higher cost of cultivation, unfair trade, and illegal collection.[11] In the olden days, as evident from the concept of substitute drugs (*Pratinidhi Dravya*) was available in *Yogratnakara, Bhavaprakasha, Bhaishajya Ratnawali,* and *Vaidya Chintamani*.[12] Therefore, Charka and others have also dealt with authentication and standardization of herbal drugs and formulations in detail using five Pramanas (*Rasa*/taste, *Guna*/nature, *Veerya*/potency, *Vipaka*/results, and *Prabhava*/action). As per literature[13-23] and current objective, the present study has been carried out to revamp the gap for selection and validation of the alternate raw drugs in comparison to original as mentioned in text for the future industrial demand, developments and supply, regulations, quality compliances, sustainability, and possible long-term conservation.

2. MATERIALS AND METHODS

Alternatives of an Ayurvedic Pharmacopoeia of India (API) species were studied and analyzed with Ayurvedic, Taxonomical, and Phytochemicals points of view such as *Rasa, Guna, Veerya, Vipaka,* and *Prabhava* versus species, genus, family, and order along with bioactive chemical markers (BCM). The available literature, data, published papers, compendium of phytochemical constituents, floras and monographs were reviewed for selection of the alternatives.

3. RESULTS

As per Ayurveda, the possible selection of the alternate species may be region to region and person to person and in view of diagnosis of the disease and ailments. As per literature when the original drug is not available, then a drug with similar bioequivalent (*Rasa, Guna, Veerya, Vipaka* and *Prabhava*) is to be selected and used in place of the original/genuine drugs.[13-23] Alternate plants may represent all five characteristics (*Rasa, Guna, Veerya, Vipaka,* and *Prabhava*) versus species, genus, family, and order as per Ayurvedic and botanical/ taxonomical point of view.[24-28]

As per API, leaves of *Abies spectabilis* (D. Don) Mirb, tuberous roots of *Aconitum chasmanthum* Stapf. ex Holmes, root, bark, and fruits of *Aegle marmelos* L., heartwood of *Aquilaria agallocha* Roxb., roots of *Berberis aristata* DC., roots of *Cissampelos pareira* L., Oleo-gum-resin of *Commiphora wightii* (Arnott) Bhandari, seeds of *Embelia ribes* (Burm.) F., roots of *Gmelina arborea* Roxb., roots of *Hemidesmus indicus* (L.) R. Br., seeds of *Hydnocarpus kurzii* (King) Warb, rhizomes of *Nardostachys grandiflora* Wall. ex DC., root bark of *Oroxylum indicum* (L.) Kurz, rhizomatous roots of *Picrorhiza kurrooa* Royle, galls of *Pistacia integerrima* Stewart ex Brandis, roots of *Premna integrifolia* L., heartwood of *Pterocarpus santalinus* L. f., roots of *Rotheca serrata* (L.) Steane and Mabb., bark of *Saraca asoca* (Roxb.) Wild, root bark of *Stereospermum suaveolens* (Roxb.) DC, whole plant parts of *Swertia chirayita* (Roxb. ex Flem.) Karst, bark of *Symplocos racemosa* Roxb, bark of *Tecomella undulata* (Sm.) Seems, and flowers of *Viola odorata* Linn, are used in Ayurveda which has been suggested for the possible alternates with plants and plant part use.

3.1. Ayurvedic Characterisation

Talishpatra (*A. spectabilis*) consists of Tikta, Madhur (*Rasa*); Laghu, Tikshna (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Vatsnabh (*A. chasmantham*) represents Madhur (*Rasa*), Tikshna (*Guna*), Ushna (*Veerya*), and Madhur (*Vipaka*). Bael (*A. marmelos*) comprises Kashay, Tikta (*Rasa*); Laghu, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Agaru (*A. agallocha*) consists of Tikt (*Rasa*); Ruksha, Tikshna (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Daruharidra (*B. aristata*) represents Tikta, Kashay (*Rasa*); Laghu, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Patha (*C. pareira*) comprises Tikta (*Rasa*); Laghu, Tikshna (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Guggulu (*C. wightii*) comprises Tikta (*Rasa*); Ruksha, Tikshna (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Vidanga (*E. ribes*) contains Katu, Kashay (*Rasa*); Laghu, Ruksha, Tikshna (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Gambhari (*G. arborea*) comprises Tikta, Kashay, Madhur (*Rasa*); Guru (*Guna*), Ushna (*Veerya*); and Katu (*Vipaka*). Anantmool (*H. indicus*) contains Madhur, Tikta (*Rasa*); Guru, Snigdha (*Guna*); Sheet (*Veerya*); and Madhur (*Vipaka*). Chaulmoogra (*H. kurzii*) represents Katu, Tikta (*Rasa*); Tikshna, Snigdha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Jatamansi (*N. grandiflora*) consists of Tikt (*Rasa*); Tikshan, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Syonak (*O. indicum*) comprises Tikta, Kashay, Madhur (*Rasa*); Laghu, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Kutki (*P. kurroa*) contains Tikta (*Rasa*); Ruksha, Laghu (*Guna*); Sheet (*Veerya*); and Katu (*Vipaka*). Karkatshringi (*P. integerrima*) comprises Tikta, Kashay (*Rasa*); Laghu, Ruksha, (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Agnimantha (*P. integrifolia*) represents Tikta, Kashay (*Rasa*); Ruksha, Laghu (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Raktchandan (*P. santalinus*) consists of Tikta, Madhur (*Rasa*); Guru, Ruksha (*Guna*); Sheet (*Veerya*); and Katu (*Vipaka*). Bharangi (*R. serrata*) consists of Tikta (*Rasa*); Laghu, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Ashoka (*S. asoca*) characterizes as Kashay, Tikta (*Rasa*); Laghu, Ruksha (*Guna*); Sheet (*Veerya*); and Katu (*Vipaka*). Padal (*S. suaveolens*) represents Tikta, Kashay (*Rasa*); Laghu, Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Chirata (*S. chirayita*) consists of Tikta (*Rasa*); Ruksha (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*). Lodhra (*S. racemosa*) represents Tikt, Kashay (*Rasa*); Laghu, Snigdh (*Guna*); Sheet (*Veerya*); and Katu (*Vipaka*). Rohitak (*T. undulata*) comprises Tikta, Kashay (*Rasa*); Laghu, Ruksha (*Guna*); Sheet (*Veerya*); and Katu (*Vipaka*). Banfsha (*V. odorata*) represents Tikta (*Rasa*); Laghu, Snigdh (*Guna*); Ushna (*Veerya*); and Katu (*Vipaka*), respectively.

3.2. Botanical Characterization

Seven species of Abies are found in India including one introduced/ planted. Order (Pinales), Family (Pinaceae), Genus (Abies), and Species (*A. spectabilis*). Thirty-three species of the Aconitum in India. Order (Ranunculales), Family (Ranunculaceae), Genus (Aconitum), and Species (*A. chasmantham*). Aegle is a monotypic taxon. Order (Sapindales), Family (Rutaceae) Genus (Aegle), and Species (*A. marmelos*). Two species of the Aquilaria in India. Order (Malvales), Family (Thymelaeaceae), Genus (Aquilaria), and Species (*A. agallocha*). Sixty-four species of Berberis are found in India. Order (Ranunculales), Family (Berberidaceae), Genus (Berberis), and Species (*B. aristata*). Cissampelos is a monotypic taxon. Order (Ranunculales), Family (Menispermaceae), Genus (Cissampelos),

and Species (*C. pareira*). Seven species of Commiphora are found in India. Order (Sapindales), Family (Burseraceae), Genus (Commiphora), and Species (*C. wightii*). Fourteen species of Embelia are found in India. Order (Ericales), Family (Primulaceae) Genus (Embelia), and Species (*E. ribes*). Six species of Gmelina are found in India. Order (Lamiales), Family (Lamiaceae), Genus (Gmelina), and Species (*G. arborea*). Hemidesmus is a monotypic taxon. Order (Gentianales), Family (Apocynaceae), Genus (Hemidesmus), and Species (*H. indicus*). Seven species of Hydnocarpus in India. Order (Malpighiales), Family (Achariaceae), Genus (Hydnocarpus), and Species (*H. laurifolia*). Nardostachys is a monotypic taxon. Order (Dipsacales), Family (Caprifoliaceae), Genus (Nardostachys), and Species (*N. grandiflora*). Oroxylum is again monotypic taxon. Order (Cucurbitales) Family (Bignoniaceae), Genus (Oroxylum), and Species (*O. indicum*). One species of Picrorhiza and allied Neopicrorhiza found in India. Order (Lamiales), Family (Plantaginaceae), Genus (Picrorhiza), and Species (*P. kurrooa*). Three species of Pistacia in India. Order (Sapindales), Family (Anacardiaceae), Genus (Pistacia), and Species (*P. integerrima*). Thirty-eight species of Premna in India. Order (Lamiales), Family (Lamiaceae), Genus (Premna), and Species (*P. integrifolia*). Eleven species Pterocarpus in India. Order (Fabales), Family (Fabaceae), Genus (Pterocarpus), and Species (*P. santalinus*). Four species of Rotheca are found in India. Order (Lamiales), Family (Lamiaceae), Genus (Rotheca) and Species (*R. serrata*). Saraca is also a monotypic taxon although, three are now planted/introduced. Order (Fabales), Family (Fabaceae), Genus (Saraca), and Species (*S. asoca*). Two species of Stereospermum are found in India. Order (Lamiales), Family (Bignoniaceae), Genus (Stereospermum), and Species (*Stereospermum colais*). Thirty-five species of Swertia in India. Order (Gentianales), Family (Gentianaceae), Genus (Swertia), and Species (*S. chirayita*). Thirty-three species of Symplocos in India. Order (Ericales), Family (Symplocaceae), Genus (Symplocos), and Species (*S. racemosa*). Tecomella is a monotypic taxon. Order (Lamiales), Family (Bignoniaceae), Genus (Tecomella), and Species (*T. undulata*). Thirty-five species of Viola are found in India. Order (Malpighiales), Family (Violaceae), Genus (Viola), and Species (*V. odorata*) are studied for the substitution of the plants and plant part use.

3.3. Phytochemical Characterization

BCM of *A. spectabilis* (Abiesin, N-triacontanol, B-sitosterol, abietane), BCM of *A. chasmantham* (Pseudo-aconitine, bikhaconitine, chasmaconitine, indaconitine), BCM of *A. marmelos* (Marmelos, marmesinin, aegelin, lupeol, rutin), BCM of *A. agallocha* (2-phenylethyl, 4H-chromen-4-one derivatives), BCM of *B. aristata* (Berberine, berbamine), BCM of *C. pareira* (Pelosine, Bebeerine), BCM of *C. wightii* (Guggulsterol I-V, guggulsterone E and Z), BCM of *E. ribes* (Embelin, quercitol, schristembine), BCM of *G. arborea* (Beta-sitosterol, gmelinol, arborone, isoarboreol, melanore), BCM of *H. indicus* (hyperoside, hexatriacontance, hemidesminine, hemidesmin), BCM of *Hydnocarpus laurifolia* (Hydnocarpin, chaulmugric and hydnocarpic acids), BCM of *Nardostachys jatamansi* (Jatamansic acid, nardal, nardin, sesquiterpenes), BCM of *O. indicum* (Baicalein, Tetuin, Oroxindin, Chrysin), BCM of *P. kurrooa* (Kutkoside, Picroside, Kutkiol), BCM of *P. integerrima* (Alkaloids, flavonoids, tannins, saponins), BCM of *P. integrifolia* (Premnine, Ganiarine, Ganikarine), BCM of *P. santalinus* (Santalin, pterocarpin, savinin, pterolinus, and pterostilbenes), BCM of *R. serrata* (D-mannitol, hispidulin, cleroflavone, apigenin, scutellarein), BCM of *S. asoca* (quercetin, kaempferol, sitosterol, luteolin), BCM of *Stereospermum suavelolens* (Naphthoquinone, sitosterol, n-triacontanol, lapachol), BCM of *S. chirayita* (Swertisin, christian, Xanthones), BCM of *S. racemosa* (Symplocoside, symposide, leucopelargonidine-3, rhamnetin), BCM of *T. undulata* (Tecomin, lapachol, α-lapachone, β-tecomaquinone), and BCM of *V. odorata* (Violin, odoratin, salicylates) are reviewed for the selection of the alternates/substitution.

3.4. Alternates Following Synergy

In terms of Rasa, Guna, Veerya, Vipaka, and Prabhava (*Ayurveda*); Species, Genus, Family, and Order (*Taxonomy*) and BCM (*Phyto-chemistry*); *A. spectabilis* (Talishpatra) may be alternate with *Abies pindrow* and *Abies densa. A. chasmanthum* (Vatsnabha) may be substituted and with *Aconitum balfourii, Aconitum atrox, Aconitum falconerii, and A. marmelos* (Bael) plant part use that may be alternate with stem and branches bark instead of tree trunk bark and roots. *A. agallocha* (Agar) plant part use may alternate with mature bark and sapwood instead of the heartwood. *B. aristata* (Daruharidra) plant or part use may alternate with *Berberis asiatica, Berberis lycium, Berberis chitria,* and *Berberis petiolaris. C. pareira* (Patha) may be substituted with stem or aerial parts instead of roots. *C. wightii* (Guggulu) may alternate with the *Commiphora* spp. having E&Z. *E. ribes* (Vidanga) plant or part use may be alternate with *Embelia tsjerium-cottam, Embelia parviflora, Embelia nutans, Embelia floribunda, Embelia undulata, Embelia drupacea,* and *Embelia sessiliflora. G. arborea* (Gambhar) may alternate with stem and branches bark instead of root bark. *H. indicus* (Anantmool) may alternate with *H. indicus* var *pubescens* and *Decalepis hamiltonii* following the order Gentianales. *H. laurifolia* (Tubrak) may alternate with *Gynocardia indica* following the family Achariaceae. *N. grandiflora* (Jatamasi) part use may be alternate with Masi (*Morina longifolia*) following family Caprifoliaceae. *O. indicum* (Syonak) may alternate with stem and branches bark instead of root bark (Figure 1).

P. kurrooa (Kutki) may alternate with *Picrorhiza tungnathii* and *Neopicrorhiza scrophulariiflora* subsequent to genus and family. *P. integerrima* (Karkatshringi) galls as part use may be alternated with stem bark. *P. integrifolia* (Agnimantha) part used may alternate with stem and branches bark instead of roots. *P. santalinus* (Raktchandan) plant part use may alternate with mature bark and sapwood instead of heartwood. *R. serrata* (Bharangi) plants part use may alternate with stem parts. *S. asoca* (Ashoka) may alternate with stem and branches bark instead of tree trunk bark. *Stereospermum suavelolens* (Padal) may alternate with stem and branches bark instead of root bark. *S. chirayita* (Chirayita) may alternate with *S. paniculata, S. tetragona, S. alata, S. angustifolia, S. speciosa,* and *Swertia petiolata. S. racemosa* (Lodhra) may alternate with stem and branch bark instead of tree trunk bark. *T. undulata* (Rohtik) might alternate with stem bark instead of tree trunk bark and *V. odorata* (Banafsha) may alternate with *Viola betonicifolia, Viola pilosa, Viola biflora,* and *Viola canescens* root parts instead of flowers (Figure 1).

4. DISCUSSION

Today's herbal industry maintain quality standards using modern techniques and instruments like high performance thin layer chromatography (HPTLC), high performance liquid chromatography (HPLC), gas chromatography (GC), mass spectrometry (MS), liquid chromatography-mass spectrometry (LC-MS), isotope ratio-mass spectrometry (IR-MS), high resolution-mass spectrometry (HR-MS), and nuclear magnetic resonance (NMR) to adhere their quality.[9,23] Alternates should be replacement of equivalent drugs in place of original on the basis of similar chemical marker components, pharmacological

actions, and therapeutic uses.[24,25,29-36] Primary criteria for the search, evaluation, and selection of an alternate plants or plant part use should be according to *Rasa, Guna, Veerya, Vipaka,* and *Prabhava*.[8-23] Otherwise, it should be based on same Species, Genus, Family, and Order.[24-28]

Bala (*Sida cordifolia* L.) and Atibala (*Abutilon indicum* L.) both are alternates for each other. Botanical point of view Rasa Panchaka/ Dravya may be similar because both plants belong to similar order Malvales and family Malvaceae. Differences are only in genus and most probably morphological similarities may be more than 50% of characteristics.[24] Again Raktpunarnava (*Boerhavia diffusa* L.) and Swetpunarnava (*Trianthema portulacastrum* L.) are alternates for each other and substitution found based on the order Caryophyllales. Substitution between Pahadi Pashanbhed (*Bergenia ciliata* Sternb) and Pashanbhed (*Kalanchoe pinnatum* (Lam.) Kurz may be based on the order Saxifragales. Hence, in the ancient literature, the Acharya was aware and they have substituted plant species on the basis of action of the plants/raw drugs following phytogeography and ethno-medicine.[31] *Clitoria ternatea* L. belongs to family Fabaceae and *Evolvulus alsinoides* L. belongs to the family *Convolvulaceae* and *Convolvulus pluricaulis* Choisy belongs to *Convolvulaceae* are believed as alternates for each other. In this case, 50% of similarity was observed following five characteristics of Ayurveda (*Rasa, Guna, Veerya, Vipaka,* and *Prabhava*) and taxonomy (species, genus, family, and order).[26-28] Etymology, Shankhpushpi was identified as *C. ternatea* while chemical composition and pharmacological action will depend where the plants are get fit.[24]

Nagkesar (*Mesua ferrea* L.) is an important drug in Ayurveda; the authentic source is stamens substituted with flower buds of Punnag (*Calophyllum inophyllum*). Botanically, both belong to the order Malpighiales and family *Calophyllaceae*. Konch (*Mucuna pruriens* L. DC.) is substituted with similar family Fabaceae and seeds as plant part use having similarity in morphology. Etymology, Konch (snail-like shell) may be identified as *M. pruriens* instead of *Mucuna utilis* (other varieties) are popular alternates. In this case, 75% of similarity has been observed with order (Fabales), family (Fabaceae), and genus (Mucuna) versus *Rasa, Guna, Veerya,* and *Vipaka*. Gokshura/ Gaukshuru were selected only on the basis of etymology of the fruits and roots.[24] *Tribulus terrestris* and *Pedalium murex* can differentiate following taxonomic characteristics.[24-28] Botanically, they are entirely different in terms of species, genus, family, and order. *Datura metel* L. and *Datura stramonium* L. are substitutes for each other. Five features of Ayurveda (*Rasa, Guna, Veerya, Vipaka,* and *Prabhava*) and order Solanales, family Solanaceae, and genus Datura possess 75% of similarity. One of the best examples of alternatives was selection of Kustha (*Saussurea costus*) with Pushkara (*Inula racemosa* Hook.f.) instead of Kutu (*Arctium lappa* L.). Pushkarmool (*I. racemosa*) and Kustha (*S. costus*) are recognized as order Asterales and family Asteraceae. Here, the order, family, and plant part use (roots) has also been recognized same for the Ayurvedic alternates.[24]

5. CONCLUSION

The present study would be useful for sustainability and conservation of the IUCN red listed MAPs. Least Concern (LC), Near Threatened, Vulnerable (VU), Endangered (EN), and Critically Endangered (CE) are the sequences that how plant species are being extinct in the wild or in a particular district, state, and country. *A. chasmanthum* (CE), *A. marmelos* (LC), *Aquilaria malaccensis* (CE), *C. wightii* (CE), *N. grandiflora* (CE), *P. kurrooa* (EN), *P. santalinus* (CE) *S. asoca* (VU), *T. undulata* (EN), and some monotypic taxon (*H. indicus, O. indicum, and C. pareira*) have high demand in herbal industry for classical and proprietary Ayurvedic formulation. Although there may be low or high trade volumes, their availability in terms of original RM/raw drugs would be problematic in near future. Hence, there is a high need to rethink making policy and mitigation plan for the plant species listed in IUCN red list category and have monotypic genus which has mostly coming from the wild source. Cultivated source needs commercial cultivation instead of demo nursery and wild-threatened MAPs need *Ex-Situ* and *In-Situ* conservation cum commercial cultivation plan immediately.

Due to inflated demand and depleting key resources, yields as per gestation period of the plants collected from wild sources are shrinking now due to many reasons. Moreover, the price of the raw drugs/RM is constantly rising, which restricts herbal R&D and wide application for human beings. On the basis of *Rasa, Guna, Veerya, Vipaka,* and *Prabhava* or otherwise species (sub-species and variety, if any), genus, family, and order or particular active marker compounds of the selected RMs/raw drugs must have quality compliance, regulations, or pharmacological activity against particular disease and ailments. We can try to differentiate, define, and execute them for possible substitution and sustainability for conservation and future industrial demand and development or whenever unavailability of the grantha-based raw drugs.[24] On the basis of available literature, if bark parts are being used that may be recommended and substituted with stem and branches bark instead of tree trunk bark use. If roots are digging either from cultivated sources or wild/natural habitats, it should be in a sustainable way, for example, young roots, primary, secondary, or tertiary roots may be recommended and suggested for the same. Interestingly, seeds, leaves, and stem/branches may be recognized as sustainable plant parts. The renowned, *Dashamoola* (*Aegle marmelos, Oroxylum indicum, Stereospermum suaveolens, Gmelina arborea, Premna integrifolia, Desmodium gangeticum, Uraria picta, Solanum indicum, Solanum surattense, Tribulus terrestris*) plants may also be recommended to alternate use with the aerial plant parts.

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9. ETHICAL APPROVALS

This study does not require ethical approval.

10. CONFLICTS OF INTEREST

Nil.

11. DATA AVAIBALITY

This is an original manuscript and all data are available for only research purposes from principal investigators.

12. PUBLISHERS NOTE

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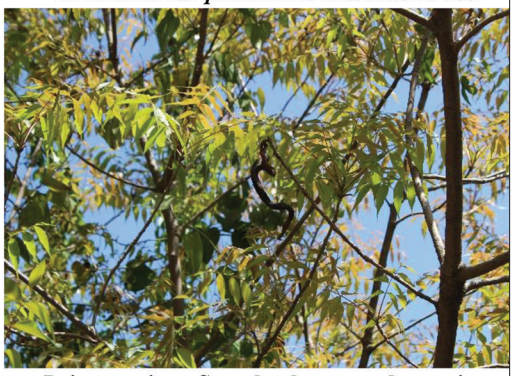
Figure 1: Grantha-based plant species and proposed alternates/alternatives

***Hemidesmus indicus*: Roots as per grantha**

***H. indicus* var *pubescens*: Alternative use**

***Pistacia integerrima*: Galls as per grantha**



***P. integerrima*: Stem bark use as alternatives**

***Picrorhiza scrophulariiflora:* As an alternative**

***Picrorhiza tungnathii:* As an alternative**

***Pterocarpus santalinus*: Bark as an alternate use**

***P. santalinus*: Heartwood as per grantha**

Figure 1: *(Continued)*


Rotheca serrata: Stem part as alternative use
R. serrata: Root as per grantha
Saraca asoca: Bark use as per grantha
S. asoca: Use of stem bark, as alternative
Tecomella undulata: Bark use as per grantha
T. undulata: Stem bark as alternatives
Viola odorata: Flowers as per grantha
Viola spp: Root as alternative source

Figure 1