Genus *Decalepis*

Subjects: Plant Sciences

Contributor: Zishan Ahmad, Abolghassem emamverdian, Muthusamy Ramakrishnan, Yulong DING

The steno-endemic species from the genus *Decalepis* are facing a high level of threat due to destructive wild harvesting. The genus claimed its paramount importance to mankind due to its unique tuberous root characteristics and exhibits a wide range of biological and medicinal properties, and is used in pharmaceutical and food industries. Plants of this genus are endemic to limited areas of peninsular India, such as the Eastern and Western Ghats, and according to the International Union for Conservation of Nature (IUCN), species from the genus *Decalepis* are considered globally critically endangered.

Keywords: medicinal plants ; natural products ; bioactive metabolites

1. Introduction

India, being a megadiverse country, possesses abundant biodiversity and it is home to more than 17,000 angiosperms [1][2], with four major hotspots (Himalaya, Western Ghats, Indo-Burma, and Sundaland) out of thirty-four hotspots [3]. The country represents 11% of the world's flora, and approximately 28% of the total Indian flora are endemic, with 33% of the angiosperms occurring in India [4]. Increasing human population and their intervention, deforestation, and agricultural land expansion in the forest area put these ecological regions at risk of extinction, requiring special attention [5][6]. The species from the genus *Decalepis* are confined to some forest area of Tamil Nadu, Kerala, and Andhra Pradesh in India [7]. Plants are found as patches on the exposed rocky slopes that faces high wind velocities and temperatures with moderate rainfall throughout the year [8]. Taxonomic distribution at family level recorded *D. hamiltonii* (Wight & Arn.), *D. arayalpathra* (J. Joseph and V. Chandras.) Venter, *D. salicifolia* (Bedd. Ex Hook.f.) Venter, *D. nervosa* (Wight & Arn.) Venter., and *D. khasiana* (kurz) Ionta ex Kambale as the accepted names of the plants under the family Apocynaceae ([9][10], http://www.theplantlist.org, accessed on 12 Feburary 2022). The species of *Decalepis* was assessed as Critically Endangered Globally and declared as a red listed medicinal plant by International Union of Conservation of Nature (IUCN) ([11][12], http://www.iucnredlist.org/details/50126587/0, accessed on 12 Feburary 2022). The National Biodiversity Authority of India (NBA) declared the species of high conservation concern [13]. The plants are in regularly use in traditional Indian and Chinese medicine to cure the disarray related to the lungs, digestive, and circulatory system, stomach ache, cancer-like affliction, peptic ulcer, and as rejuvenating tonic by the native Kani tribes of Southern Western Ghats [14][15].

The most important plant part is the root tuber, a rich center for different alkaloids and phenolics [16]. The tuberous root contains 2-hydroxy-4-methoxybenzaldehyde (2H4MB) (97%), which is a valuable source for the production of commercially important flavor compound vanillin [16][17][18][19][20]. The presence of aroma (2H4MB) in the tuberous root of these species places them as a potential substitute for *Hemidesmus indicus* on the international market [20][21]. The plant *H. indicus* is widely used in Ayurvedic and Unani systems of medicine because of its high medicinal value, viz., its anti-cancerous, anti-ulcer, anti-oxidant, anti-inflammatory, anti-hyperglycemic, anti-venom, and anti-microbial properties [22]. The tuberous root of *H. indicus* is very short and thin and rigidly attached to the soil, and in order to unearth the root tuber, extensive labor is needed, while *D. hamiltonii* tuberous roots are large and fleshy, loosely attached to the soil, and require less labor. Such availability of tuberous roots of the species from the genus *Decalepis* leads to the high demand for the plant in the global market as an alternative to H. indicus and thousands of tons are traded each year from uncultivated wild sources [12][23]. Overexploitation and haphazard collection put the genus into thrust for their survival. Thus, a convenient outline for the species from the genus *Decalepis* is needed for their sustained use, whose trade is regulated by Convention of International Trade of Endangered Species (CITES). Thus, the current communication detailing the facts about the species from the genus *Decalepis,* their geographical distribution, current status, chemical constituents, and pharmacological applications and biotechnological intervention for the advancement of *Decalepis* and their conservation through micropropagation.

2. *Genus Decalepis*: A Brief Outline

In a recent study, the recorded population of the genus *Decalepis* showed restricted distribution and occurrence due to destructive harvesting. Moreover, Niche specificity, low genetic diversity, restricted gene flow, damage caused by fruit wasp, and genetic differentiation has led to the reduction of the species in number [7]. Of the five species of *Decalepis*, *D. hamiltonii*, *D. nervosa*, and *D. khasiana* are climbing plants, while *D. salicifolia* and *D. arayalpathra* are erect shrubs found in poor soils on rocky hill slopes of evergreen forests [24][25]. The species is endemic to the Eastern and Western Ghats of peninsular India, except D. khasiana, which occupies the easternmost part of India [26].

D. hamiltonii, commonly known as Maredukommulu or Nannarikommulu in Telugu, Magalikizhangu in Tamil, and swallow root in English, is the most widely distributed species. The geographical distribution of this species is on the rocky slopes and crevices of dry and moist deciduous forests of Karnataka, Andhra Pradesh, and in Tamil Nadu [27]. However, despite its wide distribution, its population has gradually declined due to the destructive harvesting of the tuber [28]. *D. arayalpathra*, locally known as *Jankia arayalpathra*, is a perennial lactiferous shrub. Its distribution is limited to the Thiruvananthapuram district of Kerala and the Tirunelveli and Kanyakumari district of Tamil Nadu [28]. The forests of the Anamalai Hills (Kerala and Tamil Nadu), Nelliampathy (Kerala), and Marayoor (Kerala) have been documented to inhabit *D. salicifolia. D. nervosa*, is restricted to the Nilgiris mountains and the Kothgiri and Wellington region of Tamil Nadu [26].

3. Chemical Constituents and Metabolic Profiling

The demands of human beings are increasing continuously for phytomedicine due to its accuracy and consistency, leading to an emphasis on plants and their role in phytomedicine bioactivity. A large number of plant species are slowly evolving due to many reactions, including environmental impact on habitat loss, destructive collection, etc. The overall effects endanger plant populations, and most of them are poorly explored and less studied. Therefore, such plant species need greater attention for their industrial use and effective conservation with the screening of the newer secondary metabolites. Various chromatographic techniques had provided us with a broad notion to explore the biochemical composition of plant and plant parts.

Considerable effort has been made to isolate and determine the metabolites available in the species from the genus *Decalepis.* The earliest intervention in this regard was available by Murti and Seshadri [29], who claimed the presence of Inositol, saponins, tannins, phenolics, alkaloids, flavonoids, etc. in root tuber of *D. hamiltonii*. Nagarajan et al. [30] have reported a few specific metabolites, i.e., 2-hydroxy-4-methoxy benzaldehyde (2H4MB), from volatile oils (96%), which is found to be an important constituent in *D. hamiltonii*. Further work has been done to investigate the metabolic content by George et al. [31] and confirmed the presence of 2H4MB in the tuberous root of *D. hamiltonii* as major metabolites. They have also found some other minor metabolites of pharmacological value, namely 2-hydoxybenzaldehyde (31.01%), 4-O-methylresorcylaldehyde (9.12%), benzyl alcohol (3.16%), etc. The GC-MS analysis of tuberous root extract of D. hamiltonii by Nagarajan et al. (2001) observed the presence of benzaldehyde (0.01%), salicylaldehyde (0.01%), methyl salicylate (0.04%), 2-phenylethyl alcohol (0.08%), ethyl salicylate (0.03%), and vanillin (0.45%) in minor amounts that are biologically significant. Nagarajan and Rao [32] developed a chromatographic technique in which they used gas as a mobile phase and found varying combination of the aromatic compound in *D. hamiltonii*. Other compounds, such as 4-hydroxyisopthalic acid, 14-aminiotetradecanoic acid, 4-(1-hydroxy-1-methylethyl)-1-methyl-1,2-cylohexane diol, 2-(hydroxymethyl)-3-ethoxybenzaldehyde, bornerol, and ellagic acid have also been reported in *D. hamiltonii* root [33][34]. Moreover, α-atlantone (2.06% v/w of oil) and β-pinene (2.01%) have been isolated by Thangadurai et al. [35]. **Table 1** represents the GCMS analysis of methanolic root extract of *D. hamiltonii*. This table shows the presence of bioactive constituents in methanolic root extract of *D. hamiltonii* with their retention time and area percentage.

Table 1. GC-MS analysis of methanolic root extract of *D. hamiltonii*.

Peak	R. Time	Area %	Name
1	8.13	1.86	2,3-Dihydro-3, 5-dihydroxy-6-methyl-4h-pyra
2	11.05	41.72	2-hydroxy-4-methoxy- Benzaldehyde
3	12.77	1.13	Vanillin
4	12.98	1.85	1,3,5,7-Tetravinyl-1,3,5,7-tetrabutoxycyclotetrasiloxane
5	13.53	0.62	Benzoic acid, 4-ethoxy-, ethyl ester
6	15.17	7.12	Ethyl. alpha.-d-glucopyranoside

Peak	R. Time	Area %	Name
7	16.29	4.87	Methyl. beta.-d-galactopyranoside
8	16.93	0.28	4,4-Dimethyl-2-adamantanol
9	17.89	0.94	Hexadecanoic acid, methyl ester
10	18.26	3.37	Pentadecanoic acid
11	18.78	6.88	Glucose
12	19.60	1.06	9-Octadecenoic acid (z)-, Methyl ester
13	19.97	3.55	cis-Vaccenic acid
14	20.16	0.52	Octadecanoic acid
15	23.81	0.22	Isosteviol methyl ester
16	24.48	0.21	Isosteviol methyl ester
17	24.62	1.58	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester
18	25.33	0.80	1,2-Benzenedicarboxylic acid
19	27.50	0.20	Octadecanoic acid, 2,3-dihydroxypropyl ester
20	28.11	0.22	9-Octadecenamide
21	28.51	0.54	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23
22	34.70	1.37	Stigmast-5-en-3-ol, (3.beta.)-
23	36.30	0.81	Methyl Commate B
24	37.34	3.09	4,4,6A,6B,8A,11,11,14B-octamethyl-1,4,4A,5,6,6A,6
25	38.33	15.20	Methyl commate D

Some studies on the determination and evaluation of phytocompounds in *D. arayalpathra* also revealed the presence of a compound similar to that reported in *D. hamiltonii*. Ahmad et al. [16] performed the screening of metabolites for methanolic extract of tuberous root of *D. arayalpathra* and its successive fractions that revealed the presence of the alkaloid, phenolics, tannins, carbohydrate, flavonoids, terpenoids, etc. Further GC-MS analysis enabled the identification of furaneol, 2H4MB, 4H3MB (4-hydroxy-3-methoxybenzaldehyde), nerol acetate, diazoacetone, benzoic acid, neryl acetate ester, hexacontane, mome inositol, inositol, tetrapentacontane, diethyl phthalate, 4-ethoxy-ethyl, hexacontane, methyl commate D, diazoacetone, squalene as a major metabolites with chromelin, anhydride, alcohol, myristate, Benzoic acid, Lup-20(29)-en-3-yl acetate, 2,6-Octadiene-1-ol, phthalic acid, and steraloids as minor metabolites [16]. The high-performance liquid chromatography (HPLC) studies of methanolic extract of *D. arayalpathra* confirmed the presence of 2H4MB as the major constituents with chlorogenic acid having potential biological activity [16][17][18]. George et al. [36] also noted the presence of 2H4MB in the root of *D. salicifolia* as major metabolites in their early work. A recent report by Das et al. [37] witnessed the occurrence of phenolic and flavonoids compounds on *D. nervosa* phytochemical screening.

4. Pharmacology: Traditional and Modern Application

Species from the genus *Decalepis* have long been used by tribal people for the treatment of diseases related to the digestive system, lungs, circulatory system, and inflammation [38][39]. The species *D. hamiltonii* is widely used by the tribes of the Western Ghats; the roots of these plants are available in the local tribal markets in dried form and are used in the preparation of Ayurveda [39]. These dried roots are used to cure indigestion and also chewed according to their need [40]. It has been found to be effective and can be used to cure dysentery, cough, bronchitis, leucorrhea, uterine hemorrhage, skin disease, fever, indigestion, vomiting, chronic rheumatism, anemia, and blood diseases [40][41][42]. The people of Nannari, the forest regions of the Eastern and the Western Ghats, eat it in the form of pickles, which is used to treat bleeding ulcer, tuberculosis, asthma, and skin disease and also as a refreshing drink [41][42]. The root extract had also a great significance in the terms of industrial scale. It is widely used as food preservatives due to its anti-oxidant potential. In addition, it is in great demand for the nutraceuticals and pharmaceuticals industry [43].

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