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Thunia orchids and their therapeutic benefits - A review

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Abstract : Orchids are highly revered as cut flowers in international markets for their attractive blooms and are demanded for ornamental and horticultural values. In addition, orchids also possess tremendous therapeutic properties, but less emphasis is given on this aspect. In the modern world, where human populations are becoming more dependent upon herbal medicines for curing ailments, it has only become a necessity to explore deeply the pharmacological properties of plants. Orchids are sources of important metabolites and bioactive compounds, as many of the species have been reported to be rich reservoirs of phenols, flavonoids, tannins, alkaloids, phenanthrenes, bibenzyls, steroids, etc. *Thunia*, an unexplored orchid genus, needs special mention in this regard. Studies carried out on different species of *Thunia* have revealed the presence of compounds with anti-cancerous, anti-microbial, anti-inflammatory, and anti-diabetic properties especially in the species *T. alba*. Due to uncontrolled human activities such as overexploitation, habitat destruction, shifting cultivation, etc., many orchid species are becoming endangered in the wild. Therefore, conservation of orchids through sustainable approaches must go hand-in-hand with the scientific exploitation of pharmaceutical compounds. The present chapter attempts to summarise the different pharmaceutical and therapeutical properties reported so far in *Thunia* orchids.

Keywords **-** *Thunia*; bioactivity; ethnomedicine; endangered; conservation.

I. INTRODUCTION

Within the vast Plantae kingdom, Orchidaceae ranks as the second largest family of Angiosperms. This family encompasses more than 800 genera and around 25,000 to 35,000 species, displaying a wide range of diversity in the shape, size, and colour of the flowers (Thapa et al., 2023; Yang et al., 2023). The floral varieties in orchids have led to their great demand in the international market as ornamentals (Tiwari et al., 2023). The orchids also play significant roles in the ecosystem as ecological indicators, symbionts, and mediums for the mating of pollinator bees (Tsiftsis and Djordjević, 2020; Kirillova et al., 2023). Moreover, they are reported to be highly medicinal with different therapeutic properties such as anti-cancerous, anti-diabetic, anti-inflammatory, anti-viral, anti-ageing, anti-microbial, and analgesic (Bhattacharyya et al., 2023). Many of the species of *Thunia* have been utilized as ethnomedicines by different communities around the world to treat ailments which include bone fractures, skin infections, snake bites, coughs, and abortion complications (Castillo-Pérez et al., 2023). The presence of important bioactive compounds and secondary metabolites like phenols, flavonoids, alkaloids, tannins, steroids, phenanthrenes, stilbenoids, anthraquinones, pyrenes, coumarins, anthocyanins and anthocyanidins, chroman derivatives, and lignans, is reported to be responsible for imparting orchids with medicinal attributes (De, 2023). The analysis of the secondary metabolites and their associated bioactivities represent a crucial step in unlocking the potential for noble dr8ug discovery in the future (Li et al., 2023). However, due to the great demand for orchids, the diverse natural populations have been overexploited by indiscriminate collections. Furthermore, habitat destruction as a result of various anthropogenic activities like deforestation, shifting cultivation and constructions has led to diminishing wild populations of orchids (Debnath and Kumaria, 2023). At present, many orchid species are already listed on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of threatened species. Moreover, the entire family of Orchidaceae is now listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Gale et al., 2018; Bazzicalupo et al., 2023; Liu et al., 2023).

The genus *Thunia* consists of ornamentally and horticulturally important orchid species that are highly in demand for their beautiful flowers. The plants are medium-to-large in size and characterized by homoblastic pseudobulbs. Although the blooming period of *Thunia* orchids is medium-to-short-lived, the fragrant and showy flowers are in excessive demand for commercial purposes, leading to all the species becoming rare and threatened (Pongener and Deb, 2019). This genus was first described in 1852 by H.G. Reichenbach, who named it *Thunia* in honour of Count von Thun Hohenstein. It is represented by four accepted species, namely *T. alba* (Lindl.) Rchb.f.; *T. bensoniae* Hook.f.; *T. brymeriana* Rolfe; and *T. pulchra* Rchb.f., along with two accepted varieties: *T. alba* (Lindl.) Rchb.f. var. *alba*; and *T. alba* var. *bracteata* (Roxb.) N. Pearce & P.J. Cribb (POWO, 2023). However, surveys of research studies have depicted a varying number of species ranging from 4 to 7 within the genus (Magesh et al., 2013; Li et al., 2015; Zhang, 2019). Morphological characteristics of the flowers based on the colour of the lip are considered parameters for differentiating the species (Zhou et al., 2020). According to Magesh et al. (2013), in India, the genus is represented by two species namely, *T. alba* var. *alba* and *T. alba* var. *bracteata*. Subsequently, Singh et al. (2019), in their book on 'Orchids of India' have mentioned the occurrence of another representative of *Thunia viz*., *T. alba* var. *marshalliana* (Rchb.f.) (**Fig. 1**). Such taxonomic irregularities need to be addressed effectively through elaborative and descriptive scientific studies in order to address the ambiguous issues pertinent to the genus (Zhou et al., 2020). Few studies are available on the therapeutic properties of *Thunia* species, particularly *T. alba* against cough, pneumonia, bronchitis, and duodenal ulcers, where stilbenoids, bibenzyls, phenanthrenes, 9,10-dihydrophenanthrenes, phenanthropyrans, and simple aromatic compounds have been found to be the major bioactive compounds (Lin et al., 2005; Lee et al., 2008; Yan et al., 2016; Teoh, 2022). Although the curative properties of orchids are a boon to mankind, without proper documentation of their medicinal attributes, their true potential cannot be harnessed. Hence, there is a need to document the ethnomedicinal and herbal benefits of orchids. The present chapter attempts to summarise the different pharmaceutical and therapeutical properties reported so far in *Thunia* orchids.

Fig. 1. *Thunia marshalliana* (a) A potted plant; (b) Plant with inflorescence

II. DISTRIBUTION OF *THUNIA* SPP.

The genus *Thunia* is distributed in Bhutan, China, India, Indonesia, Malaysia, Myanmar, Nepal, Thailand, and Vietnam (Mathew, 2013; Singh et al., 2019; Govaerts, 2023). In India, the representatives of *T. alba* are reported to be found in the Northeastern states (Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, and Sikkim), the Eastern region (Odisha and West Bengal), the Northern region (Himachal

Pradesh and Uttarakhand), and the Southern region (Andhra Pradesh, Karnataka, Kerela, and Maharashtra) (Magesh et al., 2013; Singh et al., 2019). The herbarium sheets for *Thunia* spp. are available in the online repository of the Royal Botanic Garden, Kew (https://powo.science.kew.org/) (**Fig. 2**).

Fig. 2. The herbarium sheets of *Thunia* spp. available in the Royal Botanic Gardens Kew
(a) *T. alba*; (b) *T. bensoniae*; (c) *T. brymeriana*; (d) *T. pulchra*

III. PHYTOCHEMICAL AND THERAPEUTICAL PROPERTIES

Orchids have been used in traditional curative practises since ancient times, with the Chinese being the first to describe orchids for their therapeutic properties. However, scientific studies on their pharmaceutical properties for potential drug discovery are still lagging (Bazzicalupo et al., 2023). Orchids are reported to be important sources for secondary metabolites and act as alternatives for increasing dependency on herbal therapy (Arora et al., 2023). Since the recent past, researchers have shown keen interest in the medicinal properties of orchids, with numerous attempts being made to discover new bioactive compounds (Rahamtulla et al., 2023). Similar studies have been carried out for *Thunia* orchids, especially in *T. alba,* for the presence of secondary metabolites (**Fig. 3**). Majumder et al. (1998) isolated the compound thunalbene from *T. alba*, a stilbene derivative that was discovered for the first time in the family Orchidaceae. With the help of spectral and chemical analyses, the structure of thunalbene was established as 3,3′-dihydroxy-5-methoxystilbene (**Fig. 4**). This compound was found to possess antioxidant, anti-inflammatory, anti-cancerous, anti-diabetic, and anti-analgesic activities (Moon et al., 2015). In addition, six known stilbenoids with high therapeutic activities were also subsequently identified from the species which included batatasin-III, lusianthridin, 3,7-dihydroxy-2,4-dimethoxyphenanthrene, 3,7-dihydroxy-2,4,8-trimethoxy-phenanthrene, cirrhopetalanthrin, and flavanthrin. Of these, batatasin-III has been extensively studied and reported to have anti-inflammatory, anti-cancerous, and selective anti-biotic properties (Pinkhien et al., 2017; Hasriadi et al., 2022; Farha et al., 2023). Lusianthridin, another important bioactive compound with anti-cancerous and anti-oxidant activities, has been reported in this species (Bhummaphan et al., 2019; Thant, 2020; Swe et al., 2021). The phenolic compound, 3,7-dihydroxy-2,4-dimethoxyphenanthrene found in *T. alba* is reported to have vasorelaxant properties (Estrada-Soto et al., 2006; Xu et al., 2019), while flavanthrin has anti-cancerous activity and an inhibitory effect on SARS-CoV-2 (Mahmud et al., 2021). Earlier in 2016, Yan et al. reported the presence of coelonin in *T. alba* in addition to other bioactive compounds. This compound has been found to have anti-inflammatory activity, as reported by Jian et al. (2019). The phenanthrenes and bibenzyls, reported to be the characteristic chemical markers for *T. alba*, have been shown to possess various biological activities such as anti-inflammatory, anti-oxidation, anti-bacterial, anti-allergic, anti-algal, anti-trypanosomal, vasorelaxant, and anti-cancerous activities (Majumder and Lahiri, 1990; Kuo et al., 2008; Morita et al., 2011; Otoguro et al., 2012). Xu et al. (2019) reported seven new phenolic compounds from *T. alba* with potent antioxidant activities, which included 2,4,7-Trihydroxy-9,10-dihydrophenanthrene; 2,8-Dihydroxy-3,4,7-trimethoxyphenanthrene; 7-Hydroxy-2,4-dimethoxy-9,10-dihydrophenanthrene (orchinol); 2,5-Dihydroxy-4-methoxy-9,10-dihydrophenanthrene; 2-Hydroxy-4,7-dimethoxy-9,10-dihydro-phenanthrene; 3,3′,5-Trihydroxybibenzyl; and 2,7-Dihydroxy-1-(p-hydroxybenzyl)-4-methoxy-9,10-dihydroxy-phenanthrene. These compounds have been known from other orchid species to have anti-cancerous, anti-inflammatory, anti-diabetic, anti-viral, anti-hepatic, and anti-fungal properties (Fisch et al., 1973; Yang et al., 2008). While 4,7-Dihydroxy-1-(p-hydroxybenzyl)-2-methoxy-9,10-dihydroxyphenanthrene isolated from the orchids showed anti-hepatic fibrosis activity (Liu et al., 2017; Ya-ping et al., 2019). Fig. 4 shows the structures of the bioactive compounds identified in the species *T. alba*.

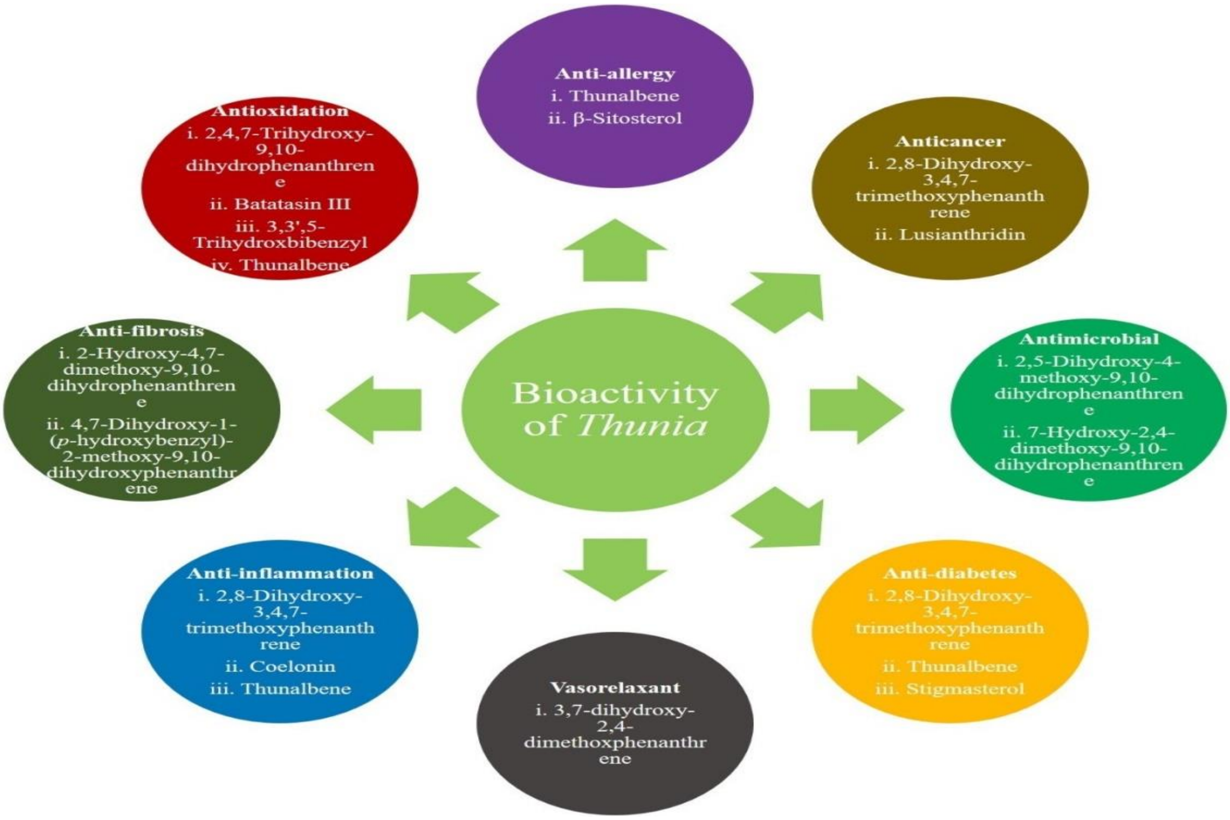

Fig. 3. Some major bioactive compounds of *Thunia* spp. and their reported bioactivities

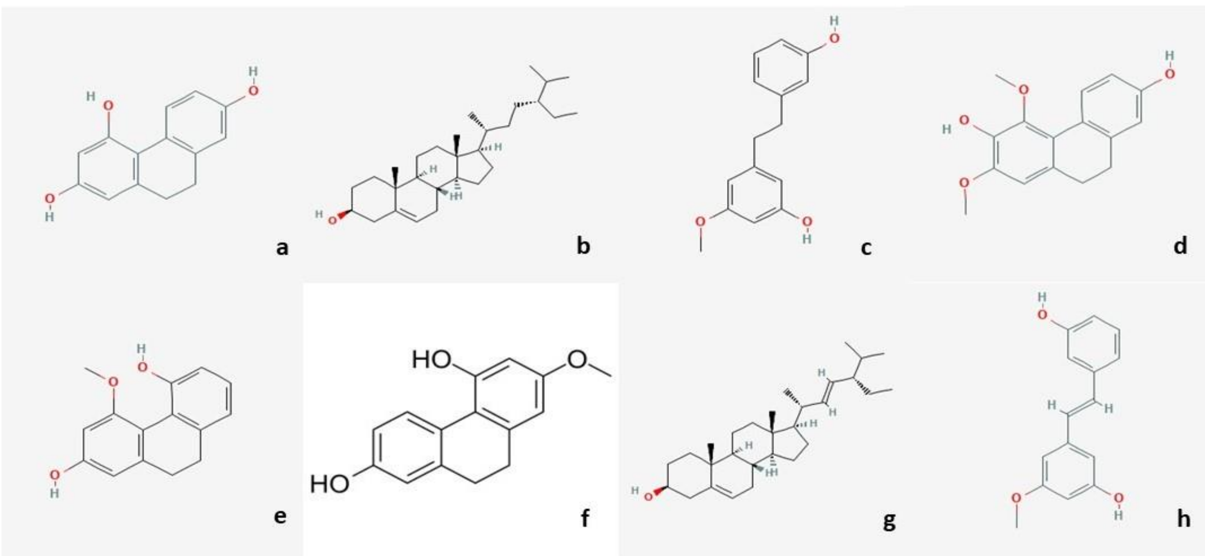

Fig. 4. Some major bioactive compounds identified from *Thunia alba* (a) 2,4,7-Trihydroxy-9,10-dihydrophenanthrene; (b) β-Sitosterol; (c) Batatasin III; (d) Flavanthridin; (e) Hircinol; (f) Lusianthridin; (g) Stigmasterol; (h) Thunalbene

The presence of a rich content of secondary metabolites in *T. alba* has contributed to its therapeutic values. The ethnic people of the Yunnan province in China use the roots, leaves, and homoblastic pseudobulbs of this species for the treatment of cough, pneumonia, bronchitis, and duodenal ulcers (Yan et al., 2016). In addition, the paste made from whole parts of the plant is applied externally to treat dislocated bones (Tsering et al., 2017). So far, only the therapeutic properties of *T. alba* are available and therefore, other species of the genus need to be explored scientifically so as to establish their true potential in the pharmaceutical industry. However, it is also critical to consider sustainable approaches towards harnessing such benefits from medicinal orchids, as at present most of the members of the Orchidaceae are overexploited.

IV. FUTURE PROSPECTS OF *THUNIA* ORCHIDS

In general, the pharmacological values of orchids need more extensive investigation through targeted analysis of bioactive compounds. The effectiveness of the anti-cancerous, anti-inflammatory, anti-diabetic, anti-aging, analgesics, anti-bacterial, anti-viral, and wound- healing properties of *Thunia* spp. needs proper validation. In addition, till date, only a handful of protocols are available for mass multiplication of *Thunia* spp. (Singh et al., 2014). Therefore, efficient *in vitro* propagation techniques must be developed for the conservation of orchid germplasm and the maintenance of a continuous supply of secondary metabolites for future utility in the pharmaceutical industries.

V. CONCLUSION

Thunia orchids are a relatively unexplored group of orchids with tremendous scope for further research in the fields of microbial interactions, pharmaceuticals, micropropagation, hybridisation, genomics and metabolomics.

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