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Medicinal Orchids in India and their Conservation: A Review

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ABSTRACT

Application of traditional knowledge for the utilization of natural products, particularly of plant origin, has gained importance in the past several decades. For the tribal people of different parts of India, there is limited alternative to herbal medicines, which they have used for time immemorial. Along with other medicinal plants, orchids are considered to be an important source of herbal medicine. Orchids are among the most diverse of the flowering plant families, with over 181 genera and 1229 species specific to India. Orchids, which are well known for their floriculture value, are also used for curing several diseases. Due to over-exploitation for medicinal use and for the cut-flower trade, many orchids have become either rare or endangered. This review attempts to summarize the use of micropropagation to conserve Indian orchids of medicinal significance.

Keywords: ethno-medicinal, herbal medicine, orchids, tribal, traditional knowledge
Abbreviations: CITES, convention of international trade in endangered species

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INTRODUCTION

Nature has bestowed mankind with a wonderful gift in the form of plants. Neither man nor animal can exist without the contribution of plant communities on this earth. India harbors a wide range of plant varieties due to its varied climatic conditions. Approximately 17,500 flowering plant species are known from India (Rout 2004), almost 10,000 of which are herbs. Taxonomic studies by many eminent botanists recorded that orchids are native to India (Misra 2004). The ancient Greeks were the first to take note of these strange plants. The word orchid is derived from the term *orchis*, meaning testis. The name orchid was adopted by Discorides (1st Century A.D.) in his "Materia Medica". Indian vedic scriptures also mentioned these plants under the name "*Vanda*" which has been adopted as the generic name of one of the most important orchids. Orchids are herbaceous plants, and the family contains an estimated 800 genera and 25,000 species (Chuga *et al.* 2009).

DISTRIBUTION OF ORCHIDS

Orchids are found in all parts of the world except in extremely cold regions of the Arctic, hot deserts and aquatic and marine ecosystems. According to the mode of distribution, orchids could broadly be grouped as tropical and temperate. The majorities of orchids which are now in cultivation, however, are natives of tropical climates and occur in greatest profusion in humid tropical forests of central and South America, India, Indonesia, Japan, Kenya, Myanmar, Mexico, Madagascar, Mauritius, Malaysia, Nepal, Peru, Philippines, Sri Lanka, Singapore, Thailand, Vietnam, and many other countries (Misra 2007). Orchids are now commercially grown in Malaysia, Singapore, Thailand and several other countries. Most orchids have beautiful flowers, but many have small or inconspicuous flowers, too. Tribal people of New Guinea prepare attractive bracelets from the yellow pseudo stems of *Dendrobium utile* to use them as ornaments. There are several orchids whose plant itself is ornamental even without the flowers such as *Lusia*, *Oberania* and *Cymbidium*. Orchids, particularly those of epiphytic origin, are very slow growing, probably due to their mode of carbon acquisition. Incidentally, the most economically important orchids are epiphytic in origin (Hew and Yong 2004).

IMPORTANCE IN CUT-FLOWER INDUSTRY

Orchids are now conspicuously found in the international trade as both cut flowers and pot plants. The flower industry

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Mini-Review

Table 1 Ethno-medicinal uses of some orchids*.

Botanical name	Vernacular Name	Part used	Therapeutic use(s)
Acampe papillosa	Rasna	R	In rheumatism
Acampe praemosa	Rasna	R	In rheumatism
Ansellia mumilis	NA	R	As antidote to bad dreams
Cymbidium aloifolium	Malanga	Rh	Asthmatic and purgative
Cirrhopetalum maculosum	Swaranjiwanti	R	For longevity
Cypripedium elegans	NA	R	As nerve tonic; in hysteria, spasms, fits, madness, epilepsy and rheumatism
Dendrobium alpestre	Jiwanti	B	For treating pimples, boils and other skin eruptions
Eulophia campestris	Salen; Amrits	T	As aphrodisiac; for cough and heart trouble
Habenaria accuminata	Kakoli	R	As tonic
Habenaria intermedia	Ridhi varidhi	R	As tonic
Liparis rostrata	NA	T	For stomach trouble
Lusia tenuifolia	NA	R, Rh	As emollient and poultice for boils. Abscesses and tumors
Microstylis wallichii	Jiwak	Pb	As tonic
Orchis latifolia	Salem	R	As tonic and expectorant
Pholidota articulata	NA	S	As tonic
Satyrium sp.	NA	S	As tonic
Vanda cristata	Rasna	L	As expectorant
Vanda roxburgii	Bandanika	L	In rheumatism
Vanda spathulata	Ponnamponm-araiva	L	In asthma and mania
Zeuxine strateumatica	Shwethuli	R	As tonic

* Lewis and Elvin-Lewis (1977); Behera (2008); Singh and Duggal (2009)
B: bulb; L: leaf; Pb: pseudo bulb; Rh: rhizome; R: root; T: tuber; S: stem; NA: Not available

in India did business of more than 300 million US$ per year, a substantial part of which was contributed by orchids (Sachdeva 2003), including growing orchids through seeds and micropropagation (Bhattacharjee 1995). Most orchid growers have their own nurseries from where plants are either sold as pot plants or used for large-scale cut-flower production. Promising varieties are purchased by commercial orchid growers paying a heavy price. Now-a-days, orchids such as *Dendrobium*, *Cymbidium*, *Cattleya*, *Spathoglottis* and *Vanda* are cultivated on a large scale in glasshouses for their valuable cut-flowers.

IMPORTANCE OF ORCHIDS IN TRADITIONAL MEDICINE

In many countries like China and in some parts of Europe and America, Australia and Africa, orchids have been used as traditional drugs for a very long time (Bulpitt *et al*. 2007). The ethno-botanical value of several orchids is also discussed in 'Charaka Samhita', a classic Indian Medicinal treatise written by Charaka in Sanskrit a thousand years ago. People of the middle ages even believed that orchid plants came from the drops of semen which fell to earth in meadows where animals came together to breed (Schweinfurth 1959). The Europeans believed that orchids were a symbol of sex. *Cypripedium pubescens* roots contain volatile oils, tannins, sugars, starch and other components. The usefulness of the root drug of this species is also indicated in the treatment of stomach worms and in allaying joint pain (Lewis and Elvin-Lewis 1977). Compounds from orchid are important in reducing fever, increasing the white blood cell counts, curing eye infections, treating fatigue and headache, and most importantly, functioning as an anti-cancer agent (Bulpitt 2005). About 40 *Dendrobium* species have been used in traditional Chinese medicine, five of which (*D. chrysanthum*, *D. fimbriatum*, *D. loddigesii*, *D. nobile* and *D. officinale*) are listed in the Chinese Pharmacopoeia (Chinese Pharmacopoeia Editorial Committee 2000).

India harbors a wide range of medicinal and aromatic plants mostly used in Ayurveda, homeopathic, allopathic and other alternative medicinal practices. Ayurveda and Traditional Chinese Medicine (TCM) were essential in exploring the medicinal value of this group of plants (Singh and Duggal 2009). The medicinal value of a *Vandaceous* taxon and of some other taxa, including *Eulophia dabia* (D.Dan) Hochy, *Flickingeria nodosa* (Dali) Seident, and *Malaxis rheedii* SW. are discussed in 'Charaka Samhita'. This is the first record of Indian orchids and their uses in Ayurvedic medicine. In India, orchids are employed for a variety of therapeutic uses in different systems of traditional medicine (**Table 1**). In the Ayurvedic system of medicine, a group of eight drugs, known as ashtavarga, is employed in the preparation of a number of rejuvenating formulations and tonics. Asthavarga is an important ingredient of various classical Ayurvedic formulations like Chavyanprasa (Singh and Duggal 2009).

Vanda has a long history of use by the native population for its anti-inflammatory properties (Kumar *et al*. 2005; Behera 2008). Indian *Vanda* does indeed express antiproliferative effects against various types of cancers, including those from choriocarcinoma (cancer of germ cells), lung cancer, and stomach cancer (Ho and Chen 2003). The *Vanilla* genus is important as a source of natural vanilla flavouring. The fresh dried stem of *Dendrobium nobile* is used in the preparation of a drug that works as an aphrodisiac, analgesic and for longevity (Uma Debi *et al*. 2009). Furthermore, its flowers can cure eye ailments (Mandal and Datta 2003). Some orchid species have been in use as an antidote for scorpion bite and for curing ailments. Tuber paste of *Habenaria fusifera* is used for cuts, wounds and poisonous bites. Tuber extract of *Habenaria plantaginea* and *H. roxburghii* are used for scorpion and snake bites by tribals. Paste obtained from leaf of *Acampe praemorsa*, *Lusia zeylanica* and aerial roots of *Cymbidium aloifolium* are used for fixing human bone fractures (Behera 2008). *Dendrobium macraei*, an important orchid from an Ayurvedic point of view is reported to be a source of Jivanti (Kasera and Shukla 2001). A total of 365 plants, including several orchids are listed in the earliest known Chinese Materia Media. Even today, the psedobulbs of *Bulbophyllum* and *Dendrobium* are sold on the market under the name 'Purusha-ratna'. Orchids, particularly *Dendrobium* species, have been used as medicinal herbs in different continents for centuries. The use of dried orchids ranges from immune system build-up, eye-sight improvement, and regaining strength after healing (for healers) and enhanced sex ability in males (Singh and Sandhu 2005). Many reports on ethno-botanical studies have been made by several researchers within India (Jain 1971; Ray Choudhury *et al.* 1975; Girach and Aminoddin 1987; Das and Mishra 1987, 2000; Brahmam and Saxena 1990; Mohapatra and Choudhury 2005; Jalal and Rawat 2009). In Nepal, medicinal orchids were listed, together with their conservation strategy by Acharya and Rokaya (2010). Tubers of *Bulbophyllum neilgherrense* are consumed to improve health. Pseudobulb extract of *Malaxis acuminata* is used in tonic preparations and of *Pholidota imbricata* to treat rheumatic swellings (Bulpitt 2005). In India, work has been carried out on

Table 2 Some phytochemicals isolated from orchids.

Name of phytochemical	Phytochemical class	Source
Acridin	Phenanthropyran	*Aerides crispum*
Agrostophyllinol	Triterpenoid	*Agrostophyllum brevipes*, *A. callosum*
Isoagrostophyllol	Triterpenoid	*Agrostophyllum callosum*
Orchinol, 6-methoxycoelonin, imbrication, flaccidin, oxoflaccidin, isooxoflaccidin, flaccidinin, agrostophyllin, callosin, callosinin, callosumin, callosuminin and callosumidin	Stilbenoids	*Agrostophyllum collosum*
Arundinan	Stilbenoid	*Arundina graminifolia*
Cypripedin	1-4 phenanthrenequinone	*Cypripedium calceouspubescens*
Loroglossin	Glucoside	*Orchis latifolia*
Jebantine	Alkaloid	*Dendrobium macraci*
Gigantol	Bibenzyl	*Dendrobium nobile*
Moscatilin	Bibenzyl	*Dendrobium nobile*
Dendrobine	Alkaloid	*Dendrobium nobile*
Nudol	Phenanthrene	*Eulophia nuda*
Melianin	Glycoside	*Vanda roxburghii*
Nidemin	Triterpenoid	*Nidema boothi*
Kinsenoside	Glycoside	*Anoectochilus formosanus*
Rotundatin and moscatin	Phenanthrene	*Dendrobium moscatum*
Gymopusin	Phenanthrene	*Bulbophyllum rymopus*

* Data collected from: Singh and Duggal 2009; Gutierrez 2010

chemical analysis of some medicinally useful orchids e.g. *Eulophia campestris*, *Orchis latifolia*, *Vanda roxburgii* (Lewis and Elvin-Lewis 1977). Traditional medicines used by tribals and their phytochemistry (**Table 2**) are well documented by Gutierrez (2010).

Some ethnobotanical studies in Orissa are fragmentary and incomplete in nature (Saxena and Brahamam 1994; Misra 2004), although studies on indigenous knowledge of herbal medicine plant resource utilization and conservation of biodiversity from around the world are diverse (Hossain 2011). In many village markets, medicinal herbs are sold alongside vegetables and practitioners of herbal medicine often undergo rigorous and extended training to learn the nomenclature (vernacular), use and preparation of native plants.

Several species of *Eulophia* are thought to prevent miscarriage and cure barrenness. *Eulophia flaccida* in powdered form is applied to incisions made on the skin and is believed to relieve pain rapidly, flowers of *Vanda spathulata* are powdered and treated to cure hysteria while many species of orchids, including *Dendrobium*, are fed to milk cattle for enhancing milk yield (Singh and Duggal 2009). Verma *et al*. (2011) reported the use of many ethno-botanically important orchids used by the tribal population of Himachal Pradesh, India.

CONSERVATION OF ORCHIDS IN INDIA

Orchidarium and orchid sanctuaries

Orchids enjoyed a special place in the life and culture of ancient Indians and were conserved directly or indirectly in the hermitages of great sages and in the sanctuaries created by kings. Now, the orchids of India are treated as protected plants. In recent years a number of wildlife sanctuaries and reserves have been set up in different phytogeographical regions of India. Some states have taken special initiatives for the protection of orchids in their natural habitats, i.e., *in situ*, for example Appangala in Karnataka, Loleyangaon and Darjeeling areas in West Bengal have been designated as orchid reserves by their state Governments. Orchid sanctuaries have been set up in Deorali and Singtam in Sikkim and Sessa in Arunachal Pradesh (Hegde 1983, 1984). Preservation, maintenance and appropriate management of native orchid habitats are the prime motive of an orchid conservation programme. Living germplasm conservation is maintained in the Regional Plant Resource Center (RPRC), Odisha, India, accompanied by mass propagation through *in vitro* (or *ex situ*) culture.

In vitro conservation through micropropagation

During the last 50 years the tissue culture techniques have been extensively exploited, not only for the rapid and large-scale propagation of orchids but also for their *ex situ* conservation. Orchids primarily reproduce sexually but they reproduce a great deal through conventional means i.e. back-bulbs, shoot division, etc., but this growth is rather slow and yields only few plants even after several years (Vij 1995). Different protocols have been developed for the large-scale propagation of number of orchid species through *in vitro* culture of various parts including shoot tip, root tips, nodes of different region (see Teixeira da Silva and Van, this volume). *In vitro* seedlings are a great task for large-scale production of orchids. Mass propagation using conventional and tissue culture techniques are thus an important strategy to save natural population from the pressure of commercial collection (Murashige and Skoog 1962; Vij 1993).

Embryo culture

Since embryo sac development is a post-pollination phenomenon and fertilization a prerequisite for obtaining seedlings, therefore, very young ovules do not form suitable explants in these plants. Moreover, as the ovules can be used for raising cultures immediately after fertilization, the development stage of the ovules when they can be successfully germinated varies from species to species (Vij 1995; Sharma 1996; Hossain 2008). The asymbiotic germination potential of seeds, representing different development stages, has been positively tested in several threatened Indian orchid taxa (Hegde 1990; Pathak *et al*. 1992; Shrama and Tendon 1986, 1987, 1990; Vij and Arora 1988; Vij and Pathak 1988a, 1988b; Pant and Gurung 2005; Behera *et al*. 2011; Nongdam and Chongtham 2011; Pant *et al*. 2011). Representative studies are outlined in **Table 3**.

Meristem culture

Orchids are out breeders and generate a great deal of heterozygote in their progeny. Therefore, propagation through embryo culture appears to be a disadvantage in cut-flower industry, where pure lines of desired genotypes are preferred. Possibility of using excised shoot-meristems for regenerating complete plants of *Cymbidium in vitro* and formulated, described and published a procedure for the purpose, the technique of meristem (shoot tip, auxiliary bud) culture has opened new vistas in orchid micropropagation (Arditti and Ernest 1993).

Table 3 Mass propagation through embryo culture.

	Medium used	Explants source (*in vitro*/*in vivo*)	Results	Reference
Spathoglottis plicatta Bl.	Mitra orchid medium + 1 mg/l BAP + 1 mg/l NAA	*In vivo*	Shoots	Behera *et al*. 2011
Cymbidium aloifolium (L.) Sw.	MS + 1 mg/l BAP + AC	*In vivo*	Shoots	Nongdam and Chongtham 2011
Aerides odorata Lour	MS + 1.5 BAP + 0.5 NAA	*In vivo*	Shoots	Pant and Gurung 2005
Phaius tancarvilleae (L' Her) Blume	MS + 1.0 mg/l BAP	*In vivo*	Shoots	Pant *et al*. 2011
Goodyera biflora (Lindl.) Hook. f.	NA	*In vivo*	PLBs	Pathak *et al*. 1992
Coelogyne punctuate Lindl.	NA	NA	NA	Sharma and Tendon 1986
Cymbidium elegans Lindl. & *Coelogyne punctulata* Lindl.	NA	NA	-	Sharma and Tendon 1990
Pachystoma senile (Lindley) Reichb. F.	NA	NA	NA	Vij and Arora 1988
Cymbidium macrorhizon	NA	NA	NA	Vij and Pathak 1988a
Pholidota articulata Lindl	NA	NA	NA	Vij and Pathak 1988b

*AC: activated charcoal; BAP = 6-benzylaminopurine; MS: Murashige and Skoog medium; NA: not available; NAA: 1-naphthaleneacetic acid; PLB: protocorm-like body

Table 4 Mass propagation through shoot tip culture.

	Medium used	Explants source (*in vitro*/*in vivo*)	Results	Reference
Cymbidium aloifolium (L.) Sw.	N&N medium	*In vitro*	PLBs	Devi *et al.* 1997
Vanilla planifolia Andr.	MS + 1 mg/l BAP + 150 ml/l CW	*In vivo*	Shoots	Kalimuthu *et al*. 2006
Anoectochilus formosanus Hayata	Hyponex medium + 1 mg/l BAP/ 1-2 mg/l	*In vivo*	Shoot buds	Ket *et al.* 2004
Phaius tancarvilleae (L' Her) Blume	Raghavan and Torrey's (1964) basal medium	*In vitro*	Shoots	Nagaraju and Parthasarathy 1995
Dendrobium wardianum Warner	MS + 2.5 mg/l BAP	*In vivo*	PLBs	Sharma and Tandon 1992
Dendrobium Joannie Ostenhault	VW + 15% CW	*In vitro*	PLBs	Sharon and Vasundhara 1990
Dendrobium cv. Sonia	VW + 1 mg/l BAP + 1.5 mg/l NAA	*In vivo*	Shoot buds	Sheela *et al.* 2004
Cymbidium atropurpureum (Lindl.) Rolfe	VW + 5.0 mg/l NAA	NA	PLBs	Subramanium and Taha 2003

* BAP = 6-benzylaminopurine; CW: coconut water; MS: Murashige and Skoog medium; NA: not available; NAA: 1-naphthaleneacetic acid; PLB: protocorm-like body; VW: Vacin and Went medium

Table 5 Mass propagation using leaf as explants.

	Medium used	Explants source (*in vitro*/*in vivo*)	Results	Reference
Micropera pallida Lindl.	½ MS + 2 mg/l NAA + 2 mg/l BAP	*In vitro*	PLBs	Bhadra and Hossain 2004
Dendrobium chiengmai	½ MS + 18.16 µM TDZ	*In vitro*	PLBs	Chung *et al*. 2005
Vanilla planifolia Andr.	MS + 4.52 µM 2,4-D + 2.22 µM BAP	*In vivo*	Callus	Janarthanam and Seshadri 2008
Dendrobium hybrids	MS + 44 µM BAP	*In vitro*	PLBs	Martin and Madassery 2006
Aerides maculosum Lindl	MS + 2 mg/l BAP	*In vitro*	PLBs	Murthy and Pyati 2001
Acampe praemorsa (Roxb.) Blatter and Mc Cain	MS + 0.5 mg/NAA + 1 mg/l TDZ	*In vitro*	Shoot buds	Nayak *et al*. 1997a
Phaius tancarvilleae (L' Her) Blume	MS + 1.0 mg/l BAP	*In vitro*	Shoots	Pant and Shrestha 2011
Phalaenopsis hybrids	MS + 88.8 µM BAP + 5.4 µM NAA	*In vitro*	PLBs	Park *et al*. 2002a
Doritaenopsis hybrid	MS + 88.8 µM BAP + 5.4 µM NAA	NA	PLBs	Park *et al*. 2002b
Vanda cristata Lindl.	MPR + 10 mg/l BAP + 5 mg/l IAA	*In vivo*	PLBs	Sharma and Vij 1997
Spathoglottis plicata Blume	½ MS + 0.2% activated charcoal + 5.37 µM BAP + 0.44 µM NAA	*In vivo*	PLBs	Teng *et al.* 1997
Ascocenda varieties	MPR medium + 1 mg/l BAP	*In vitro*	PLBs	Vij and Kaur 1999
Cymbidium sp.	MPR + 2 mg/l BAP + 0.5 mg/l NAA	*In vitro*	PLBs	Vij *et al*. 2004a
Aerides multiflora Roxb.	MPR + 2 mg/l BAP + 0.5 mg/l NAA	*In vitro*	PLBs	Vij *et al*. 2004b

* BAP = 6-benzylaminopurine; MS: Murashige and Skoog medium; NA: not available; NAA: 1-naphthaleneacetic acid; PLB: protocorm-like body; TDZ: thidiazuron

The proliferative potential of explants from shoot tip of *Vanda coerulea* and successful establishment of the clonal plants in forest segments of the Western Ghats (Seeni and Latha 2000). Success in callus culture in which the callus can be maintained for a prolonged period through subculture has been limited to a few orchids (Chang and Chang 1998; Ishii *et al*.1998; Roy and Banerjee 2003). This is primarily due to the difficulty in introduction, limited growth and severe necrosis of callus (Roy *et al.* 2007). However, the survival incidence of the smaller explants was low and the plant multiplication rate also remains slow (Chugh *et al*. 2009). The micropropagation of some orchids using shoot tips as explants are done by different author in different species (Sharon and Vasundhara 1990; Sharma and Tandon 1992; Nagaraju and Parthasarathy 1995; Devi *et al.* 1997; Subramanium and Taha 2003; Ket *et al.* 2004; Sheela *et al.* 2004; Kalimuthu *et al*. 2006). Representative studies are outlined in **Table 4**.

Unlike shoot tips, foliar explants are easy to obtained and do not require the sacrifice of the mother plant. Wimber (1965) as a pioneered leaf tissue culture and gave the first well documented report on production of PLBs from *Cymbidium* leaves. Successful regeneration of a large number of uniform plants from leaf tissue culture of endangered *Renanthera imschootiana* Rolfe, also known as red *Vanda* and endangered blue *Vanda*, has been reported (Seeni and Latha 1992, 2000). So many workers had working on orchid micropropagation, using leaves as explants (Nayak *et al*. 1997; Sharma and Vij 1997; Teng *et al.* 1997; Vij and Kaur 1999; Murthy and Pyati 2001; Park *et al*. 2002a, 2002b; Vij *et al*. 2004a, 2004b; Bhadra and Hossain 2004; Chung *et al*. 2005; Martin and Madassery 2006; Janarthanam and Seshadri 2008; Pant and Shrestha 2011). Representative studies are outlined in **Table 5**.

In the root and rhizome explants, the effect of an exogenous supply of plant growth regulators is species specific and it varies from during initiation, multiplication and differentiation of culture. In this connection, it is worthwhile to mention that root-cap is an active site of IAA accumulation and the transformation of root Meristem into a shoot Meristem is positively influenced by the endo and/or exogenous level of auxin (Philip and Nainar 1988). Micro-

Table 6 Mass propagation through root segment culture.

	Medium used	Explants source (*in vitro*/*in vivo*)	Results	Reference
Cymbidium ensifolium var. misericors	½ MS + 10 mg/l 2,4-D + 0.1 mg/l TDZ	*In vitro*	Callus	Chang and Chang 1998
Clowesia warscewiczii (Lindl.) Dodson	VW + 0.001 mg/l 2ip	*In vitro*	PLBs	Kerbuy and Estilla 1996
Vanda sp.	½ MS + 1 mg/l NAA + 3mg/l TDZ	*In vivo*	PLBs	Lang and Hang 2006
Ipsea malabarica (Reichb. F.) J.D. Hook	½ MS + 6.97 µM Kn	*In vitro*	Shoots	Martin 2003
Cymbidium aloifolium (L.) Sw.	MS + 4.4 µM BAP +0.1 µM NAA	*In vitro*	Shoot buds	Nayak *et al.* 1998
Doritaenopsis varieties	MS + 2.3 µM TDZ	*In vitro*	PLBs	Park *et al*. 2003
Geodorum densiflorum (Lam.) Schltr.	MS + 5.0 µM BAP	*In vitro*	Shoots	Sheelavantmath *et al*. 2000
Dendrobium transparens L.	MS + 2.0 mg/l BAP + 1 mg/l NAA	*In vitro*	Shoots	Sunitibala and Kishor 2009
Cattleya Almakee	MPR + 1 mg/l Kn + 1 mg/l NAA	*In vitro*	PLBs	Vij 1993
Cymbidium Kenny 'Wine colour'	MS + 1 mg/l NAA + 1 mg/l BAP	*In vitro*	PLBs	Yasugi *et al*. 1994

2,4-D: 2,4-dichlorophenoxyacetic acid; 2ip: (2-isopentyne) adenine; BAP = 6-benzylaminopurine; MS: Murashige and Skoog medium; NA: not available; NAA: 1-naphthaleneacetic acid; PLB: protocorm-like body; TDZ: thidiazuron; VW: Vacin and Went medium

propagation of some orchids using rhizome and root segment cultue are done by many workers in different species (Vij 1993; Yasugi *et al*. 1994; Kerbuy and Estilla 1996; Nayak *et al.* 1998; Chang and Chang 1998; Sheelavantmath *et al*. 2000; Martin 2003; Park *et al*. 2003; Wu *et al*. 2004, 2007; Lang and Hang 2006; Sunitibala and Kishor 2009). Representative studies are outlined in **Table 6**.

Problems and prospects for conservation of orchids

Conservation and management of orchids require a proper understanding of their reproductive biology and concerted efforts to preserve their habitats. The extinction of species, particularly in endemics, has to prevent by ensuring that the threatened species are restored to safer limits and the non-threatened stocks are not allowed to decline further. Due to huge interaction of the tribal people and the local traders, the forest ecosystems are being to be destroyed during few years. The Convention of International Trade in Endangered Species (CITES) of wild flora and fauna, in 1975, suggested many measures of ex situ and in situ conservation of orchids (Vij 2001). Protection of natural habitats by establishing, Sanctuaries, Biosphere reserve and forest reserves; salvation of plants from damaged and threatened habitats and their culture in Orchidaria, Botanical gardens and other Rescue Centers and propagation of threatened plants through *in vivo/in vitro* and their re-introduce into well protected habitats are among other measures suggested for orchid conservation.

CONCLUSION

Ornamental and medicinal plants are on demand in the global market in terms of floriculture and herbal drugs. Orchids have both floriculture value and medicinal properties that is more demanding in the international market. The exploration of orchids for antimicrobial property is a great task for the conservationist in this field. The endemic and rare orchids with ethno-medicinal properties need attention for their scientific exploration for use of human welfare. Development of new hybrids of orchids and their commercial cultivation have now become a profitable business in many countries of the world (Behera 2008). Cost efficient protocols for mass propagation of rare, threatened and endangered orchids, new hybrids, as well as transgenic orchids have to be developed further in order to commercialize and conserve this unique group of plants. The loss of biodiversity is a major threat for the scientific community to think about the conservation of these species in the natural habitats (Jalal *et al*. 2009). Though, huge no of jurisdiction laws are made for the conservation of flora and fauna in India, lack of awareness among the people cause wipe out the forest ecosystem. Furthermore, orchids are mostly terrestrial and epiphytic, that implies the loss of big plants and forest fire can ultimately damage to the natural habitats of orchids. *In situ* conservation is a part of conservation strategies for the orchid species but there is a dire need of *ex situ* conservation in their natural habitats.

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