

## Review

# Orchids: A review of uses in traditional medicine, its phytochemistry and pharmacology

Rosa Martha Pérez Gutiérrez

Punto Fijo 16, Col. Torres Lindavista cp 07708, Mexico D.F, Mexico. E-mail: rmpg@prodigy.net.mx.

Accepted 8 December, 2009

Many of the epiphytic Orchids are used as traditional medicine. Chemical components and pharmacology have been studied in recent 15 years. Medicinal orchids, in general, are not subjected to detailed pharmacological studies. A wide range of chemical compounds are presented including alkaloids, bibenzyl derivatives, flavonoids, phenanthrenes and terpenoids which have been isolated recently from this species. Extracts and metabolites of these plants, particularly those from flowers and leaves, possess useful pharmacological activities. Particular attention has been given to diuretic, anti-rheumatic, anti-inflammatory, anti-carcinogenic, hypoglycemic activities, antimicrobial, anticonvulsive, relaxation, neuroprotective, and antiviral activities. A comprehensive account of chemical constituents and biological activities is presented and a critical appraisal of the ethnopharmacological issues is included in view of the many recent findings of importance of these orchids. A large number of orchids have been empirically used for treatment of different diseases, thus, several studies have been undertaken to provide scientific proof to justify the medicinal use of various plants in treatment of diseases. The aim of this review is to up-date and to present a comprehensive analysis of traditional and folklore uses, pharmacological reports and phyto-constituents isolated from the Orchids family.

**Key words:** Orchids, medicinal plant, traditional uses, chemical constituents, biological activities.

## INTRODUCTION

Orchid family (Orchidaceae) is the second largest family of flowering plants with approximately 20,000 species with more than 850 genera. This diversity increases towards the tropic; where the epiphytic species predominate that almost constitute 73% of the family. Colombia is the country with greatest number of species in America (3000 spp.) followed by Ecuador and Brazil (2,500 spp. each one), (Dressler, 1981). Germination of orchid seeds fully depends on a symbiotic association with soil-borne fungi, usually *Rhizoctonia* spp. In contrast to the peaceful symbiotic associations between many other terrestrial plants and mycorrhizal fungi, this association is a life-and-death struggle. The fungi always try to invade the cytoplasm of orchid cells to obtain nutritional compounds. On the other hand, the orchid cells restrict the growth of the infecting hyphae and obtain nutrition by digesting them. It is likely that antifungal compounds are involved in the restriction of fungal growth (Shimura et al., 2007). Orchid have numerous varieties of exquisitely beautiful blossoms which are sold

commercially, the only economically important product in this great plant family is the delicious spice known as vanilla. Vanilla comes from several species of perennial vines of the genus *Vanilla* native to Mexico and tropical America. The Aztecs originally used vanilla as a flavoring for chocolate, and the Spanish conquerers carried it back to Europe where it was used for this same purpose (Dressler, 1981).

One of the most famous ornamental orchids is the black orchid, *Paphiopedilum wardii* (Figure 1), this attractive species has light green leaves mottled dark green, with redpurple spotting on the underside of the leaf, which was first describe in 1950. For hundreds of years orchid growers have been searching and hoping for a truly black orchid, as there is a certain fascination with black blooms that is rather hard to explain. While some say that they have seen a black flower orchid, the general opinion is that this is false, and that no orchid is truly black, but rather a deep blue or something of the sort, which may appear as black to the eye. The black flower



Figure 1. *Paphiopedilum wardii*.

orchid is then, in essence, nothing more than a myth. Black flower orchid is also a name which is sometimes used for the *Coelogyne* flower (Braem et al., 1998). In this paper, it was thought it worth updating in view of the recent structure determinations of macromolecules and delineation of their activities through bioevaluations. This review is intended to provide the currently available information on traditional and local knowledge, ethnobotanical and ethnomedical issues, identification of pharmacologically important molecules, and biochemical and pharmacological studies of this useful plant.

## HISTORY

The Chinese were the first to write books about orchids. In 1233, Chao Shih-Keng wrote *Chin Chan Lan P'u*, and described 20 species and how to grow them (Berliocchi, 2004). In 1247, Wang Kuei-hsueh wrote his *Treatise on Chinese orchids*, and described 37 species. The first Western volumes dedicated to orchids did not appear until Eberhard Rumphius (1628 - 1702) *Herbarium Amboinense* was eventually published in 1741 - 1755, two of 12 volumes being devoted to orchids. There is no doubt that the Chinese were the first to cultivate and describe orchids, and they were almost certainly the first to describe orchids for medicinal use. Reinikka in 1995 reports a Chinese legend that Shên-nung described *Bletilla striata* and a *Dendrobium* species in his *Materia Medica* of the 28th century BC. The earliest Middle East report of plant remedies is in a 4000-year-old Sumerian clay tablet included some orchids (Kong et al., 2003). Dioscorides, who was a Greek working as a Roman military physician, wrote his *De Materia Medica*, including two terrestrial orchids (Dioscorides, 1543). He adopted and promoted the 'Doctrine of Signatures' whereby plants

were used for medicinal purposes according to their resemblance to parts of the human anatomy, for example by shape or colour. Naturally this led to orchid tubers being used to heal diseases of the testicles, and to stimulate lust. Moreover if given to men as whole fat new tubers this was supposed to produce male progeny, and if the shrivelled old tubers were given to women, this should produce female children. William Turner in the first book *English Herbal* (1568) gave four main uses, including the treatment of alcoholic gastritis (Turner, 1568). Eleven years later, Williams Langham reported anti-pyretic, anti-consumption and anti-diarrhoeal effects (Langham, 1579). John Parkinson in 1640 still thought the tubers increased fertility in men.

The genus *Dracula* Luer belongs to the subtribe Pleurothallidinae was created by Dr. Carlyle Luer (1978) by splitting off certain species with hairy flowers and different type of lip from the large genus *Masdevallia*. The first *Dracula* spp. was found by plant hunters in the 1870s, and they are still being discovered mainly in the cloud forests of Colombia, Ecuador and Peru (Luer, 1993). There are now over 100 recognised species. Colours range from white through shades of yellow, pink, blood red to dark maroon, almost black. Usually combinations of several of these colours are present as shading, fine or large spots, or lines (Torgils and Dag, 2003).

## BOTANY

The most represented genera of orchids were *Dendrobium* (183 species), *Bulbophyllum* (62 species), *Eria* (53 species), *Coelogyne* (43 species), *Vanda* (31 species), *Habenaria* (30 species), *Haemaria* (20 species), *Liparis* (20 species) and *Paphiopedilum* (19 species) (Dressler, 1960). The medicinal orchids belong mainly to the genera: *Calanthe*, *Coelogyne*, *Cymbidium*, *Cypripedium*, *Dendrobium*, *Ephemerantha*, *Eria*, *Galeola*, *Gastrodia*, *Gymnadenia*, *Habenaria*, *Ludisia*, *Luisia*, *Nevilia* and *Thunia* (Szlachetko, 2001).

Genus *Anoectochilus* (Orchidaceae), which comprise more than 40 species, is widespread throughout the tropical regions, from India through the Himalayas and Southeast Asia to Hawaii. Several species of this genus are used in Chinese folk medicines, such as *A. formosanus* Hayata, *A. koshunensis* Hayata, and *A. roxburghii* (Wall.) Lindl. Of these plants, *A. formosanus* and *A. koshunensis* are distributed only in Taiwan Province (China) and Okinawa (Japan). *Anoectochilus roxburghii*, which is distributed in southern China, Japan, Sri Lanka, India, and Nepal (Zhong et al., 2000), is also called "King Medicine" in China. However, limited scientific information is available on the bioactivity, physiological function, and specific clinical efficacy of this herbal orchid plant. Studies on this plant have focused

mainly on its material symbiosis with fungus and asepsis seedlings (Fan et al. 1997). Genus *Bulbophyllum*, a member of the Orchidaceae family, consists of over 1000 species found in Africa and Asia is widely distributed in China, Nepal, Sikkim, Bhutan, India, Burma, Thailand, Laos and Vietnam. It is a rich source of aromatic compounds such as phenanthrenes and bibenzyls. *Bulbophyllum kwangtungense* Schlecht (Chinese name "Shi dou-lan") has long been used in traditional Chinese medicine as a Yin tonic (Yi et al., 2005).

Genus *Cymbidiums* tend to grow more leaves than most orchids. Roughly eight long, green, narrow leaves originate from the sheath of each pseudobulb. It is one of the most popular and desirable orchids in the world because of the beautiful flowers. These plants make great houseplants, and are also popular in floral arrangements and corsages. They have been cultivated for thousands of years, especially in China. *Cymbidiums* became popular in Europe during the Victorian era. One feature that makes the plant so popular is the fact that it can survive during cold temperatures.

*Dendrobium* species (Orchidaceae), locally known as "Shihu" or "Huangcao" in China are widely distributed throughout Asia, Europe and Australia by more than 1100 species. There are 74 species and 2 variations of *Dendrobium* plants found in China and about 30 species of them are used in traditional or folk medicine for antipyretic, eyes-benefiting, immunoregulatory purposes, etc. The aerial parts of these plants are often collected, cut into pieces, and then dried for medicinal usages. For their similar morphologies, it is so difficult to discriminate exactly from each other, that the drug markets of *Caulis Dendrobii* are always complex with the officially recorded species (Chinese Pharmacopoeia, 2005), other substitutes or false. So it is an important issue to comprehensively evaluate the different origins of *Dendrobium*, as to ensure the clinical efficacy. Moreover, in recent years, due to the aggravated environment and the excessive consumption of medicinal *Dendrobium*, the amounts of wild *Dendrobium* have decreased extremely. Phenols comprising bibenzyl, phenanthrene and fluorenone are the main active components in *Dendrobium* with over 60 structures identified pharmacological studies have demonstrated that some of them such as erianin, moscatilin displayed antitumor, anti-angiogenic, anti-platelet aggregation, anti-inflammation and immunoregulatory activities which support that determination of all types of phenols could be a better strategy for the comprehensive quality evaluation of *Dendrobium*. On the other hand, bibenzyl and phenanthrene are most characteristic as chemical marker for genus *Dendrobium*, as the presence of over 40 compounds of those types were reported from this genus. Furthermore, fluorenone is special for genus *Dendrobium*, and no other genus was found to produce fluorenone up to date (Chapman and Hall, 2005). *Dendrobium* is, after *Bulbophyllum*, the second

largest genus with 1200 species of epiphytic orchids. These orchids are widely distributed in Southeast Asia in Indonesia, the Philippines and Papua New Guinea (Yang et al., 2006).

### Use in traditional medicine

More recent ethnopharmacological studies show that orchids are used in many parts of the world and in treatment of a number of diseases (Table 1): skin, infectious diseases, problems concerning the digestive, respiratory reproduction organs, the circulation, against tumours, for pain relief and for reducing fever.

### PHARMACOLOGICAL PROFILE

Throughout the ages, several health-promoting benefits, including diuretic, anti-rheumatic, anti-inflammatory, anti-carcinogenic, hypoglycemic activities, antimicrobial, anticonvulsive, relaxation, neuroprotective, and antiviral, activities have been attributed to the use of orchids extracts. In the following, scientific research supporting pharmacological properties ascribed to family Orchidaceae are reviewed.

#### Anticancer/antitumor

Water decoction of whole plant of *Anoectochilus formosanus* Hayata showed a potent tumor inhibitory activity in BALB/c mice after subcutaneous transplantation of CT-26 murine colon cancer cells. Water extract may activate murine immune responses, such as stimulating proliferation of lymphoid tissues and activating the phagocytosis of peritoneal macrophages against *Staphylococcus aureus*. Antitumor activity of *A. formosanus* may be associated with its potent immunostimulating effect (Tseng et al., 2006). In other experiment methanolic extract of *A. formosanus* were observed to induce apoptosis of MCF-7 cells (Shyur et al., 2004).

Silbenoids 3,3'-dihydroxy-2',6'-bis(p-hydroxybenzyl)-5-methoxybibenzyl and 3',5-dihydroxy-2-(p-hydroxybenzyl)-3-methoxybibenzyl isolated from the tubers of methanol extract of *Bletilla striata* showed inhibitory effect of tubulin polymerization at IC<sub>50</sub> 10 μM. On the other hand, phenanthrene and dihydrophenanthrene with a benzyl moiety (1-(p-hydroxybenzyl)-4,8-dimethoxyphenanthrene-2,7-diol and 2,7-dihydroxy-1,3-bis(p-hydroxybenzyl)-4-methoxy-9,10-dihydrophenanthrene) and dimeric phenanthrenes blestriarenes B and C, and blestrianol A were found to be three times less potent (IC<sub>50</sub>, 30 μM, respectively) than bisbenzyls indicating that the restricted diaryl ring system of phenanthrenes is unfavorable for tubulin binding. Substitution of the hydroxy group at C-4

**Table 1.** Ethnomedical use of orchids.

<b>Specie</b>	<b>Country</b>	<b>Part(s) used</b>	<b>Ethnomedical uses</b>	<b>Preparation(s)</b>	<b>Reference(s)</b>
<i>Anoectochilus formosanus</i>	Taiwan	Whole plant	Chest and abdominal pains, diabetes, fever, nephritis, hypertension, impotence, liver spleen disorders, and pleurodynia, anti-inflammatory agent	Decoction. Stem and leaves are one of the ingredients in certain medicinal oils	Satish et al. (2003)
<i>Anoectochilus roxburghii</i>	Taiwan, China, Japan	Whole plant	Treatment of fever, pleurodynia, snake bite, lung and liver disease, hypertension, and malnourished children	Decoction	Fan et al. (1997).
<i>Bletilla Formosana</i>	China	Tuber	Is associated with the lung, stomach and liver meridians and has a bitter taste and cool properties	Tuber is peeled and dried in the sun, then cut into slices or ground into a powder	Lin et al. (2005)
<i>Bletilla striata</i>	Taiwan, Nepal, Tibet, China	Tuber	Treatment of sores, ulcers and chapped skin, heal wounds, reduce swelling, and promote regeneration of tissue. Have been used to treat pulmonary tuberculosis and as hemostatic agent	Tuber is peeled and dried in the sun, then cut into slices or ground into a powder	Luo et al. (2007), Chang (1977)
<i>Bulbophyllum kwangtungense</i>	China, Japan	Tuber	Treat pulmonary tuberculosis and as hemostatic agent, promote the production of body liquid and reduce fever	Yin tonic	Wu et al. (2006)
<i>Bulbophyllum odoratissimum</i>	China, Vietnam, Nepal, Sikkim, Bhutan, India, Laos, Burma, Thailand	Whole plant	Treat tuberculosis, chronic inflammation and fracture	Infusion or decoction	Chen et al. (2007)
<i>Calanthe discolor</i>	Korea, Malaysia, South China	Whole plant	hair restoring	Infusion or decoction	Yoshikawa et al. (1998)
<i>Calanthe liukiensis</i>	South China, Korea, Malaysia	Whole plant	hair restoring	Infusion or decoction	Yoshikawa et al. (1998)
<i>Catasetum barbatum</i>	Guianas, Japan, Paraguayan	Whole plant	Febrifuge, anti-inflammatory	Infusion or decoction	Shimizu et al. (1988)
<i>Cephalanceropsis gracilis</i>	Taiwan, China	Whole plant	Cancer	Infusion or decoction	Wu et al. (2006)
<i>Coeloglossum viride</i>	Tibet	Rhizome	Memory deficits	Infusion or decoction	Zhang et al. (2006)

Table 1. Contd.

<i>Cremastra appendiculata</i>	China, Japan	Bulbs	Is associated with the liver, Spleen and stomach meridians. Its can be used internally, to fight tumors and cancers of the breast, cervix and uterus in women. Externally, it treats boils and skin lesions, and can be applied to affected parts of the body as part of a poultice or paste	Poultice or paste.	Lin and Namba (1985)
<i>Cymbidium goeringii</i>	China, Korea, Japan, India, Thailand, Vietnam	Whole plant	Used as hypotensive and diuretic activities	Infusion or decoction	Watanabe et al. (2007)
<i>Cypripedium macranthos</i>	México, Guatemala, Colombia	Rhizome	Used for skin diseases	Infusion or decoction	Shimura et al. (2007)
<i>Dendrobium amoenum</i>	China	Leaves	Skin diseases	Dried and ground	Venkateswarlu et al. (2002)
<i>Dendrobium aurantiacum</i>	Australia	Leaves	Diabetes	Infusion or decoction	Yang et al. (2006).
<i>Dendrobium candidum</i>	China	Leaves	Diabetes	Infusion or decoction	Wu et al. (2004)
<i>Dendrobium chrysanthum</i>	China	Leaves	Antipyretic, eyes-benefiting, immunoregulatory purposes, skin diseases	Dried and ground	Li et al. (2001)
<i>Dendrobium densiflorum</i>	China	Leaves	Promotes the production of body fluid	Yin tonic	Fan et al. (2001)
<i>Dendrobium fimbriatum</i>	China, Japan	Leaves	Promotes the production of body fluid. Paste applied on fractured area to set bone	Infusion or decoction. paste	Bi et al. (2003)
<i>Dendrobium loddigesii</i>	China	Leaves	Used as a tonic to nourish the stomach, replenish body fluid, and reduce fever and anticancer agent	Infusion or decoction	Ho and Chen (2003)
<i>Dendrobium moniliforme</i>	China, Taiwan	Stems	Tonic and antipyretic, longevity and as an aphrodisiac, stomachic and analgesic	Dried stems Infusion or decoction	Chen and Chen (1935)

Table 1. Contd.

<i>Dendrobium nobile</i>	China	Stems	Yin tonic to nourish stomach, promote production of body fluid and reduced fever	Tonic	Liu and Zhao (2003)
<i>Dendrobium tosaense</i>	China	Leaves	Treatment of anxiety and panic	Infusion or decoction	You et al. (1995)
<i>Ephemerantha lonchophylla</i>	China, Taiwan	Stems	It is used as a tonic to nourish the stomach, promote the production of body fluid, and reduce fever	Infusion or decoction	Chen et al. (1999)
<i>Epipactis helleborine</i>	Grecia, Mediterranean Europe	Rizoma	It is used as aphrodisiac	Infusion or decoction	Balzarini et al. (1992)
<i>Epidendrum Mosenii</i>	China, Corea	Stems	Analgesic activity	Infusion or decoction	Floriani et al. (1998)
<i>Epidendrum rigidum</i>	Mexico, North Sudamerica and Antilles	Stems	Replenish body fluid,	Infusion or decoction	Hernandez-Romero et al. (2005)
<i>Galeola foliata</i>	Morobe, Papua New Guinea	Stems	Treatment of some infections	Infusion or decoction	Khan and Omoloso (2004)
<i>Gastrodia elata</i>	Asia (Korea, China etc)	Whole plant	Treatment of convulsive diseases such as epilepsy	Infusion or decoction	Kim et al. (2001)
<i>Goodyera schlechtendaliana</i>	India	Whole plant	Tonic for internal injuries and to improve circulation	Tincture	Du et al. (2002)
<i>Gymnadenia conopsea</i>	China	Tubers	It is used as aphrodisiac	Tincture	Matsuda et al. (2004)
<i>Habenaria repens</i>	China	Tubers	It is used as aphrodisiac	Infusion or decoction	Johnson et al. (1999)
<i>Listera ovata</i>	Spain	Tubers	Sstomach disease. Externally skin tone	Tincture	Olof (1972)
<i>Maxillaria densa</i>	Mexico	Whole plant	Treatment of painful complaints. Relaxant agent	Infusion or decoction	Déciga-Campos et al. (2007a)
<i>Nidema boothii</i>	Malasia	Whole plant	Relaxant agent	Infusion or decoction	Hernández-Romero et al. (2004)

Table 1. Contd.

<i>Pholidota chinensis</i>	India, China	Pseudobulbs	Is taken for scrofula, feverish stomachache and toothache, chronic bronchitis, and duodenal ulcer	Tincture	Wang et al. (2006)
<i>Scaphyglottis livida</i>	Mexico	Whole plant	Analgesic agent, anti-inflammatory	Infusion or decoction	Déciga-Campos et al. (2007b)
<i>Spiranthes australis</i>	Trinidad and Tobago, China	Whole plant	Used for urinary problems and diabetes mellitus. Treatment of bacterial and inflammatory diseases, cancer, blood, and chest disorders	Infusion or decoction	Lans (2006), Peng et al. (2007)
<i>Spiranthes mauritianum</i>	Trinidad and Tobago	Whole plant	Used for snakebites, scorpion stings, for injuries and mange of dogs and to facilitate hunting success	Infusion or decoction	Lans et al. (2001)
<i>Spiranthes sinensis</i> var <i>amoena</i>	Nepal, China Taiwan	Roots	Aphrodisiac, treatment of hemoptysis, epistaxis, headache, chronic dysentery and meningitis	Power	Tezuka et al. (1990), Lin et al. (2000)
<i>Vanda roxburghii</i>	India	Leaf, roots	The paste es applied to the body to bring down fever. The juice is dropped in the ear for the treatment of otitis. The roots are used in dyspepsia, bronchitis, rheumatim and siatica	Leaves are pounded To form a paste. Juice	Chawla et al. (1992)
<i>Vanda tessellate</i>	India,Sri Lanka Burma	roots, leaves, flowers	Treatment of certain inflammatory conditions. It is also instilled into the ear as a remedy for otitis. Paste is applied to the body to bring down fever. The roots are used in rheumatism, nervous problems, bronchitis, dyspepsia and fever, laxative and tonic to the liver, aphrodisiac and given for impotence and barrenness.	Juice, the leaves in the form of a paste. Alcoholic extract of root and flowers.	Chopra et al. (1956), Basu et al. (1971), Suresh et al. (2000)

Table 1. Contd.

<i>Vanilla planifolia</i>	Mexico	Sheath	Used as for the treatment of hysteria, fever, impotence, rheumatism, and to increase the energy, of muscular system	Infusion or decoction	Martin de la Cruz (1552)
---------------------------	--------	--------	---	-----------------------	--------------------------

is also critical. Furthermore bisbenzyl 3,3'-dihydroxy-2',6'-bis(p-hydroxybenzyl)-5-methoxybibenzyl potentiated the cytotoxicity of SN-38 in BCRP-transduced K562 (K562/BCRP) cells (Morita et al., 2005). Studies were also carried out on microspheres of tubers of *B. striata* on angiogenesis. It produced a change of tumor microcirculation after transcatheter arterial chemoembolization: first pass perfusion MR imaging and Chinese ink casting in a rabbit model. With *Bletilla* microspheres may enhance its anti-tumor effect by inhibiting the angiogenesis (Zhao et al., 2004). The same observations have been made in other experiment when tested *B. striata* colloid on angiogenesis. Inhibits angiogenesis, through binding inhibition of vascular endothelial growth factor to its receptor (Feng et al., 2003).

Anticancer capacity of ethyl acetate extract from tuber of *Bulbophyllum kwangtungense* was determined. 7,8-Dihydro-5-hydroxy-12,13-methylene dioxy-11-methoxyl dibenz[bf]oxepin, 7,8-dihydro-4-hydroxy-12,13-methylenedioxy-11-methoxyldibenz [bf]oxepin, and 7,8-dihydro-3-hydroxy-12, 13-methylenedioxy-11-methoxyl dibenz [bf]oxepin, cumulatin, densiflorol A and plicatol B were isolated. All compounds exhibited anti-tumor activities against Hela and K562 human tumor cell lines (Wu et al., 2006). *Cephalanceropsis gracilis* is a native orchid of Taiwan. Its crude methanol extract of rhizomes showed significant cytotoxicity against human breast carcinoma (MCF-7), lung carcinoma (NCI-H460), and central nervous system carcinoma (SF-268) cell lines. Thus, successive column and preparative thin-layer chromatographic separations yielded cephalinone F showed significant cytotoxicity (Wu et al., 2006).

Cirrhoptalanthrin isolated from tuber of *Cremastra appendiculata* (D. Don) Makino showed non-selective moderate cytotoxicity with IC<sub>50</sub> values of 8.4 -13.3 μM x L(-1), against human colon cancer (HCT-8), human hepatoma (Bel7402), human stomach cancer(BGC-823), human lung adenocarcinoma (A549), human breast cancer (MCF-7), and human ovarian cancer (A2780) cell lines (Xia et al., 2005). A study to understand the molecular basis underlying the antitumor effects of *C. appendiculata* (D. Don) Makino was performed that analyzed the effects of 5,7-dihydroxy-3-(3-hydroxy-4-methoxybenzyl)-6-methoxychroman isolated from the bulb of *C. appendiculata* on proliferation and on expression of cell growth/apoptosis related molecules.

This homoisoflavanone is a potent inhibitor of angiogenesis. It inhibited basic fibroblast growth factor (bFGF)-induced *in vitro* angiogenesis and *in vivo* angiogenesis of the chorioallantoic membrane (CAM) of chick embryo without showing any toxicity (Shim et al., 2004). Similar observations were obtained in a study with the ethanol extract of the tuber of *C. appendiculata* was subjected to column chromatography to yield 2,7,2',7',2'-pentahydroxy-4,4',4'',7''-tetramethoxy-1,8,1',1''-triphenanthrene and cirrhoptalanthrin. Both compounds were evaluated against six human cancer cells, human lung adenocarcinoma, (A549), human ovarian cancer (A2780), hepatoma (Bel7402), human stomach cancer (BGC-283), human colon cancer (HTC-8), and human breast cancer (MCF-7) cell lines. Both compounds were selectively active against the human cancer cell lines used (Xue et al., 2006).

*Dendrobium chrysanthum* Wall distributed widely in south China and has been recorded in Chinese Pharmacopoeia. The stems of this plant, is locally known as 'ShiHu' or 'HuangCao'. From stems of *D. chrysanthum* was isolated a phenanthrene derivative with a spiro lactone ring, dendrochrysanene, that proved to suppress the mRNA level of TNF-alpha, IL8, IL10, and iNOS in murine peritoneal macrophages (Yang et al., 2006a). Studies carried out by Gong et al. (2004) revealed a clear anticancer activity of erianin isolated from stems of *D. chrysanthum* caused extensive tumour necrosis, growth delay and rapid vascular shutdown in hepatoma Bel7402 and melanoma A375; it inhibited angiogenesis *in vivo* and *in vitro* and induced endothelial cytoskeletal disorganization. In other study demonstrated that erianin showed potent inhibitory activity on the proliferation of HL-60 cells. The inhibition might be relative to the apoptosis induced by erianin and the altered expression of bcl-2 and bax genes in HL-60 cells (Li et al., 2001). In an investigation of the chemical constituents of *Dendrobium fimbriatum* Hook were obtained fimbriatone, confusarin, crepidatin, physcion, rhein, ayapin, scopolin methyl ether and n-octacostyl ferulate. Only fimbriatone showed potential inhibitory effects on BGC cell line (Bi et al., 2003).

4,7-Dihydroxy-2-methoxy-9,10-dihydrophenanthrene and denbinobin, isolated from the aerial part of *Dendrobium nobile* Lindl were found to be cytotoxic against A549 (human lung carcinoma), SK-OV-3 (human ovary adenocarcinoma), and HL-60 (human promyelocytic



leukemia) cell lines. Also showed antitumor activity on the life span of ICR mice intraperitoneally implanted with 1 x 10<sup>6</sup> cells of sarcoma 180 (You et al., 1995). In a screening of anticancer activity sesquiterpene glycosides, dendroside A and dendronobilosides A have been isolated from the stems of *Dendrobium nobile*. Both compounds were found to stimulate the proliferation of murine T and B lymphocytes *in vitro* (Zhao et al., 2001).

Two pimarane diterpenoids, lonchophylloids A and B were isolated from the stems of *Ephemerantha lonchophylla*. Both compounds were capable of sensitizing cells that expressed the multidrug resistance phenotype to the toxicity of the anticancer drug doxorubicin (Na et al., 1998). Subsequently, it has been reported that denbinobin also isolated from *E. lonchophylla* exhibit anti-tumor and anti-inflammatory activity. Nevertheless, the anti-tumor mechanism of denbinobin remains unclear. Denbinobin displays anticancer effects in K562 cells through the increase of levels of tubulin polymerization and deregulation of Bcr-Abl signaling (Huang et al., 2005).

*Gastrodia elata* Blume is an important medicinal plant in Korea. Ethanolic extract from rhizomes exhibit potent anti-tumor activity *in vitro* in a dose-dependent manner. The expression of CD44, cdc42, Timp-2 or RhoA mRNA did not change by the treatment, compared to that of the control. However, produced an increase in GTP-Ras expression. Together, these results suggest that the *G. elata* extract could have potential in alleviating tumorigenesis, by a GTP-Ras-dependent pathway (Heo et al., 2007). In other study, methanol extract of *G. elata* prevents serum-deprived apoptosis through activation of the serine/threonine kinase-dependent pathway and suppression of JNK activity (Huang et al., 2004). According to Huang et al. (2007) bis(4-Hydroxybenzyl)sulfide and N6-(4-hydroxybenzyl)adenine riboside were isolated from methanolic extract of rhizomes of *G. elata* potently prevented PC12 cell apoptosis on ischemic/hypoxic model to screen neuroprotective in concentration-dependent manners with EC<sub>50</sub> values of 7.20 μM and 3.7 x 10<sup>-8</sup> M, respectively, and IC<sub>50</sub> values of 42.90 μM (Ki 24.10 μM) and 4.660 μM (Ki 2.620 μM), respectively, in an adenosine A<sub>2A</sub> receptor binding assay. The same observations have been made when tested *p*-ethoxymethyl phenyl-O-β-D-glucoside and N-(*p*-hydroxybenzyl)-adenosine isolate from *G. elata*. The viability of the PC12 cells was significantly enhanced by pretreatment with these compounds (Huang et al., 2006). During the exhaustive biological studies on constituents of *G. elata* authors have reported these showed inhibitory effects on glutamate-induced apoptosis in human neuronal cells (IMR32 human neuroblastoma cells). In the case of vanillin and *p*-hydroxybenzaldehyde, known constituents of *G. elata*, significantly inhibited both intracellular Ca<sup>2+</sup> rise and apoptosis induced by glutamate. The apoptosis-inhibitory actions of these constituents may account, at least in part, for the basis of

their antiepileptic activities (Lee et al., 1999).

The traditional Chinese "Panlongcen", derived from the dried root or whole plant of *Spiranthes australis* (R. Brown) Lindl, is widely used for the treatment of several diseases. Dihydroflavonoid (2S)-5,2',6'-trihydroxy-6-lavandulyl-4"--(γ,γ-dimethylallyl)-2",2"-dimethyl pyrano-[5",6",7,8]-flavanone was isolated from ethanol extract of the roots of *Spiranthes australis*. This compound inhibits human cancer cells growth including A549, BEL-7402, SGC-7901, MCF-7, HT-29, K562, and A498 cell lines (Peng et al., 2007).

The genus *Bulbophyllum*, belonging to the Orchidaceae consists of about 1000 species found in Asia, America and Africa, and contains mainly phenanthrenes and bibenzyls. *Bulbophyllum odoratissimum* (J.E. Smith) Lindl is widely distributed in China, Nepal, Sikkim, Bhutan, India, Burma, Thailand, Laos and Vietnam and used in folk medicine. During the search for bioactive compounds from medicinal plants in Yunnan of China, a phenanthrene derivative 3,7-dihydroxy-2,4,6-trimethoxyphenanthrene was isolated from the all plant of *Bulbophyllum odoratissimum*. The compound displayed cytotoxicity against the growth of human leukemia cell lines K562 and HL-60, human lung adenocarcinoma A549, human hepatoma BEL-7402 and human stomach cancer cell lines SGC-7901 with IC<sub>50</sub> values of 14.23, 10.02, 3.42, 15.36 and 1.13 mg/ml respectively (Chen et al., 2007).

### Convulsive diseases

The rhizomes of *Gastrodia elata*, a medicinal herb, have been used traditionally for the treatment of convulsive diseases such as epilepsy in oriental countries including South Korea and still occupy an important place in traditional medicine in Asia. Methanol extract of rhizomes of *G. elata* protect the hippocampal neuronal damage induced by transient global ischemia in a gerbil model (Kim et al., 2003a). Additionally aqueous extract of rhizomes of *G. elata* was found exhibited in preventing PC12 cell apoptosis induced by serum deprivation through suppression of the JNK pathway. Bis(4-Hydroxybenzyl)sulfide and N6-(4-hydroxybenzyl)adenine riboside isolates from *G. elata* demonstrated the ability to prevent serum deprivation induced apoptosis in PC12 cell and to bind A<sub>2A</sub>-R (Huang et al., 2007). Similar results were observed with the methanol extract from *Gastrodia elata* which displays anticonvulsive effect and protective effect against hippocampal neuronal damage after kainic acid administration in mice (Kim et al., 2001).

Vanillyl alcohol is a component of *G. elata* which free radical scavenging activities, which may be responsible for its anticonvulsive properties. This finding is consistent with the generation of superoxide radical evoked by injection of iron salt into rat brain plays a critical role in ferric chloride - induced seizures. In addition, the

anticonvulsive effect may be due, at least in part, to its vanillyl alcohol component (Hsieh et al., 2000). On the other hand isolated vanillin, and vanillyl alcohol from *G. elata*, showed anticonvulsive action on the fully amygdala-kindled seizures which is an experimental model of chronic epilepsy to detect anticonvulsants (Wu et al., 1989).

*G. elata* methanol extract significantly inhibited the recovery time and severity induced by pentylenetetrazole (PTZ) treatment 4-hydroxybenzaldehyde, an analogue of *p*-hydroxybenzyl alcohol, showed an inhibitory effect on the GABA transaminase, and its inhibitory activity was higher than that of valproic acid, a known anticonvulsant. In the brain of PTZ-treated rats, brain lipid peroxidation was significantly increased, while it recovered to the control level after treatment with 4-hydroxybenzaldehyde. It may be concluded that antioxidation and positive modulation of GABAergic neuromodulation of 4-hydroxybenzaldehyde partially contribute to an antiepileptic and anticonvulsive activity of *G. elata* (Ha et al., 2000).

In other research for the anticonvulsant constituent of *Gastrodia elata* was found that gastrodin is able to elevate the neurotransmitter GABA levels in central nervous system by inhibitory action on one of the GABA degradative enzymes, brain succinic semialdehyde dehydrogenase (SSADH) (Baek et al., 1999).

Citryl glycoside, trimethylcitryl- $\beta$ -D-galactopyranoside has been isolated from the active fraction of rhizomes of *G. elata* inhibited GABA transaminase activity by 56.8% at the concentration of 10  $\mu$ g/ml (Choi et al., 2006). *Uncaria rhynchophylla* (Miq.) Jack with anticonvulsive properties and free radical scavenging in combination with *G. alata* (exhibit greater inhibition on the onset time of WDS than *Uncaria* alone). Anticonvulsive effects of both plants may be synergistic (Hsieh et al., 1999).

Goodyerin is a flavonol glycoside isolated from whole plants of *Goodyera schlechtendaliana* which has been used as a substitute for crude drug, *Anoectochilus formosanus*. The pharmacological properties of goodyerin were assayed for effects on spontaneous locomotor activity, on pentobarbital-induced hypnosis, and on anticonvulsant activity against picrotoxin-induced seizures in rodents. Goodyerin exhibited a significant and dose-dependent sedative and anticonvulsant effect (Du et al., 2002).

### Antimicrobial

The sheath *Vanilla planifolia* is described as an antimicrobial agent is not currently used in medicine for this purpose, although it may prolong the life of food products (Fladby et al., 2004). *Vanilla pompona* was also used to flavour tobacco in Cuba. Further the antimicrobial effects of vanillin and vanillic acid isolated from *V. planifolia* were studied against several species and

strains of *Listeria monocytogenes*, *L. innocua*, *L. grayi*, and *L. seeligeri*. Mixtures of vanillin and vanillic acid exhibited additive inhibitory effects, particularly at lower pH (Delaquis et al., 2005).

Another study investigated the mode of action of vanillin, the principle flavour component of vanilla, with regard to its antimicrobial activity against *Escherichia coli*, *Lactobacillus plantarum* and *Listeria innocua* was found that vanillin is primarily a membrane-active compound, resulting in dissipation of ion gradients and the inhibition of respiration, the extent to which is species-specific without decrease in production of ATP (Fitzgerald et al., 2004).

In a screening study of methylene chloride extract of *Galeola foliata* leaves and stem bark showed a broad spectrum antibacterial activity against 24 bacteria Gram-positive and Gram-negative. This extract was not active against moulds (Khan et al., 2004).

Analysis of ethanol extract of seedlings of *Cypripedium macranthos* var. *rebutense* that had developed shoots showed that it contained two antifungal compounds, lusianthrin and chrysin. The former had a slightly stronger antifungal activity than the latter, and the antifungal spectra of these compounds were relatively specific to the nonpathogenic *Rhizoctonia* spp. Lusianthrin maintains the perilous symbiotic association for germination and chrysin helps to protect adult plants (Shimura et al., 2007).

As a part of a screening study, methanol extract of leaves of *Spiranthes mauritanum* showed antibacterial activity against Gram-positive and have anti-inflammatory activity (Matu and van Staden, 2003).

In a study of herb extracts from Chinese medicinal plants, there was found that *Bletilla striata* possess antioxidant and antimicrobial capacity (Luo et al., 2007).

The orchid *Gastrodia elata* depends on fungus *Armillaria mellea* to complete its life cycle. In interaction, fungal hyphae penetrate older, nutritive corms but not newly formed corms. From these corms, a protein gastrodianin with *in vitro* activity against plant-pathogenic fungi has previously been isolated. Gastrodianin was found to be homologous to monomeric mannose-binding proteins of other orchids, of which at least one (*Epipactis helleborine* mannose-binding protein) also displayed *in vitro* antifungal activity (Wang et al., 2001).

### Anti-inflammatory

Ethanol extract from leaves of *A. formosanus* showed a delayed onset of anti-inflammatory activity starting from 4 h post carrageenan administration. However, *A. formosanus* produced histological changes such as necrosis, fatty change, ballooning degeneration, inflammatory infiltration of lymphocytes and Kupffer cells around the central vein were simultaneously improved by use of this orchid (Lin et al., 1993).

*Gastrodia elata* rhizome has been traditionally used as a folk medicine for centuries in Oriental countries. Screening the pharmacological action of the rhizome showed that methanol extracts have significant anti-inflammatory properties. In one experiment, methanol extract was fractionated for the anti-inflammatory activity-guided separation. Many phenolic compounds are isolated as 4-hydroxybenzaldehyde, 4-hydroxybenzyl alcohol, benzyl alcohol, bis-(4-hydroxyphenyl) methane, 4-(4'-hydroxybenzyloxy)benzyl methylether, 4-hydroxy-3-methoxybenzyl alcohol, 4-hydroxy-3-methoxybenzaldehyde, and 4-hydroxy-3-methoxybenzoic acid were isolated. These, not only had anti-inflammatory and analgesic properties *in vivo*, but also inhibited COX activity and silica-induced ROS generation in a dose-dependent manner. Among these phenolic compounds, 4-hydroxy-3-methoxybenzaldehyde was the most potent anti-inflammatory and analgesic. Consideration of the structure-activity relationship of phenolic derivatives from GE on the anti-inflammatory action revealed that both C-4 hydroxy and C-3 methoxy radicals of benzyl aldehyde play an important role in anti-inflammatory activities (Lee et al., 2006).

Ethanol extracts *Gastrodia elata* rhizomes, showed potently inhibited angiogenesis in chick chorioallantoic membrane assay. In a dose-dependent manner, inhibited vascular permeability induced by acetic acid and shows reduction in exudate production, leukocyte migration and nitric oxide (NO) level in rat air-pouch model. In addition, inhibited NO production and expression of inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) upon stimulation by lipopolysaccharide (LPS) in RAW264.7 macrophages. In summary, *G. elata* possesses anti-angiogenic, anti-inflammatory and analgesic activities, and *in vivo* and *in vitro* inhibitory activity on NO production (Ahn et al., 2007).

Ethyl acetate extract of *Dendrobium moniliforme* afforded a phenanthraquinone-type metabolite, 7-hydroxy-5,6-dimethoxy-1,4-phenanthrenequinone that inhibited VHR dual-specificity protein tyrosine phosphatase (DS-PTPase) activity in a dose-dependent manner (Bae et al., 2004). Additionally was isolated 2,6-dimethoxy-1,4,5,8-phenanthradiquinone with potent anti-inflammatory activity *in vitro* (Lin et al., 2001).

*Pholidota chinensis* (Orchidaceae), commonly named as Shi-Xian-To is a traditional medicinal plant distributed in the southeast of China. A report about obtained triterpenes, cyclopholidonol and cyclopholidones from this plant has been found (Li et al., 2006). In another study ethyl acetate extract of pseudobulbs of *Pholidota chinensis* L. showed strong NO production inhibitory activity in murine macrophage-like cell line, RAW 264.7, which was activated by a lipopolysaccharide (LPS) and interferon- $\gamma$  (IFN- $\gamma$ ). Fractionation of active extract led to the isolation of pholidotol A and B. Both compounds inhibited Nitric oxide (NO) production with an IC<sub>50</sub> value at 24.3 and 17.1  $\mu$ M, respectively (Wang et al., 2006).

*V. roxburghii* showed marked anti-inflammatory activity in carrageenan induced oedema in rats and mice as compared to phenylbutazone and was equipotent in adrenal-ectomised rats. In chronic models of formaldehyde and adjuvant arthritis, its anti-arthritis activity was found to be superior to that of phenylbutazone (Prasad and Achari, 1966). Heptacosane and octacosanol show anti-inflammatory activity due to the long-chain alkanes and alkanols range from C-27 to C-32 which are ubiquitous in plants (Chawla et al., 1992).

Dendroside A, C and vanilloside have been isolated from stems of *Dendrobium moniliforme*. In a preliminary biological test procedure, these compounds were found to stimulate proliferation of B cells and inhibit the proliferation of T cells *in vitro* (Zhao et al., 2003). Subsequently, it has been reported that denbinobin was isolated from stems of *Dendrobium moniliforme* showed potent antiinflammatory effects *in vitro* (Lin et al., 2001).

## Antioxidant

*Anoectochilus formosanus* is a popular folk medicine in Taiwan whose pharmacological effects have been characterized. Aqueous leaves extract showed antioxidant properties, and was capable of scavenging H<sub>2</sub>O<sub>2</sub> in a dose-dependent manner. Apoptosis caused by oxidative damage was displayed by DNA fragmentation. Cell damage induced by oxidative stress was prevented by plant extract in a concentration-dependent manner. Furthermore, proteolytic cleavage of poly(ADP-ribose) polymerase during the apoptotic process was also inhibited by extract (Wang et al., 2005). *In vivo* studies also showed that oral administration of *A. formosanus* delayed the oxidation of LDL from hyperlipidemic hamsters. Ability to scavenge free radicals suggests that it may be a promising anti-atherogenic agent (Shih et al., 2003). In the investigation of chemical constituents kinsenoside was isolated from *A. formosanus* showed antioxidant activity (Wang et al., 2002).

In several studies conducted on *Anoectochilus roxburghii* (Wall.) Lindl. The following phenol constituents were isolated: 8-hydroxybenzylquercetin (Merghem et al. 1995), isorhamnetin-7-O- $\beta$ -D-glucopyranoside, isorhamnetin-3-O- $\beta$ -D-glucopyranoside (Yu et al. 1997), kaempferol-3-O- $\beta$ -D-glucopyranoside (Markham et al., 1978), kaempferol-7 $\beta$ -D-glucopyranoside (Gong 1986), 5-hydroxy-3',4',7-trimethoxyflavonol-3- $\beta$ -D-rutinoside (Ja et al. 2002), and isorhamnetin-3- $\beta$ -D-rutinoside (Victoire et al. 1988), and quercetin-7-O- $\beta$ -D-[6"-O-(*trans*-feruloyl)]-glucopyranoside which possess scavenging activity of DPPH radicals (He et al., 2006).

Isoamoenylin, a dihydrostilbene isolated from roots of *Dendrobium amoenum* var. *denneanum*, showed moderate antioxidative and weak antibacterial activities (Venkateswarlu et al., 2002). On the other hand from stems of *D. aurantiacum* were isolated three 2-

glucosyloxycinnamic acid derivatives, namely, *cis*-mellilotoside, dihydromellilotoside, and *trans*-mellilotoside which exhibited potent antioxidant activities (Yang et al., 2007). In another research ethanol extract of stems of *D. nobile* was found to exhibit significant antioxidant activity using the DPPH assay led to the isolation of bibenzyl derivatives, with significant antioxidant activity higher than or equivalent to vitamin C (Zhang et al., 2007). In a study on the methanol extracts of *Dendrobium tosaense* Makino and *Dendrobium moniliforme* SW showed free radical scavenging active at a concentration of 0.4 mg/mL. Antioxidant components alkyl ferulates were isolated from *D. moniliforme* and quercetin from *D. tosaense* (Lo et al., 2004).

Ephemeranthone was isolated from ethanolic extract of leaves of the Chinese herbal *Ephemerantha lonchophylla*. This dihydrostilbene showed antioxidative activities for inhibiting human low density lipoprotein oxidation *in vitro* was active 5.3 times that of probucol (Chen et al., 1999).

Methanol extract of leaves of *Gastrodia elata* have major constituents vanillin, vanillyl alcohol, hydroxybenzaldehyde and hydroxybenzyl alcohol. These compounds possess antioxidant effect and the order of antioxidation potency was as follows: hydroxybenzyl alcohol > vanillyl alcohol > vanillin > hydroxybenzaldehyde. In the case of hydroxybenzaldehyde, its antioxidant effect was more potent than that of melatonin. Excellent antioxidant effects of *G. elata* and its main constituents may have potential in treatment of lipid peroxidation-associated neurological disease (Jung et al., 2007).

Alcohol extract of rhizomes of *Gymnadenia conopsea* showed effect on the collagen synthesis in rat lungs exposed to silica under the influence on antioxidant activities. The extract can ameliorate silica-induced pulmonary fibrosis by increasing activities of antioxidant and alleviating damage of lipid peroxidation to the lungs (Wang et al., 2007).

Several phenanthrenes phoyunnanins A-C, 9,10-dihydrophenanthrene 4,4',7,7'-tetrahydro-xy-2,2'-dimethoxy-9,9',10, 10'-tetrahydro-1,1'-biphenanthrene, lusianthridin, eulophiol, 2,4,7-trihydroxy-9,10-dihydrophenanthrene and imbricatin, have been isolated from 60% ethanol extract of air-dried whole plant of *Pholidota yunnanensis* Rolfe. All compounds were found to show the DPPH free radical scavenging activity with EC<sub>50</sub> from 8.8 - 55.9 μM. (Guo et al., 2007).

### Antidiabetic

Aqueous extract of rhizomes of *Anoectochilus formosanus* showed antihyperglycaemic and anti-oxidant effects in diabetic rats, and significantly reduced fasting blood glucose, serum fructosamine, triglycerides and total cholesterol. Renal lipid peroxidation levels were

significantly lower and renal reduced glutathione (GSH) concentrations were significantly higher in extract-treated diabetic rats (Shih et al., 2002).

*Dendrobium candidum* showed anti-hyperglycemic effect and its mechanisms in stimulating secretion of insulin from beta cells and inhibiting secretion of glucagons from cells, and it can probably decrease decomposition of liver glucogen and increase synthesis of liver glucogen (Wu et al., 2004).

### Diuretic

Cymbidine A isolated from *Cymbidium goeringii*, orchid is a monomeric peptidoglycan-related which involve four amino acids (D-alanin, meso-diaminopimelic acid, D-gultamic acid, and L-valine) and two amino sugars (N-acetylglucosamine and 1,6-anhydro-N-acetylmuramic acid). This compound showed hypotensive and diuretic activities (Watanabe et al., 2007). In other study gigantol was isolated which has potent inhibitory effects on LPS-induced nitric oxide (NO) and prostaglandin E production in RAW 264.7 cells. Consistent with these findings, gigantol suppressed expression of inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) at the protein and mRNA levels in RAW 264.7 cells in a concentration-dependent manner. Also gigantol is a potent inhibitor of tumor necrosis factor-alpha (TNF-alpha), interleukin-1beta (IL-1beta) and interleukin-6 (IL-6) release and influenced the mRNA expression levels of these cytokines in a dose-dependent manner (Won et al., 2006).

### Antihepatotoxic

Crude extracts of fresh whole plants of *Anoectochilus formosanus* showed inhibition of chronic hepatitis induced by CCl<sub>4</sub> in mice. Kinsenoside isolated from *A. formosanus* shows significant antihepatotoxic activity (Wu et al., 2007). In other study demonstrate that aqueous extract of *A. formosanus* can reduce liver fibrogenesis in rats induced by CCl<sub>4</sub> (Shih et al., 2005). In a study made by Shih et al., (2004) of an aqueous extract of *A. formosanus* protected the liver against dimethylnitrosamine (DMN) induced fibrosis, repair of liver injury, improvement of fibrotic changes and promotion of liver regeneration. In another study of the aqueous extract of whole plants of *in vitro* cultured *A. formosanus* showed hepatoprotective and antihyperliposis activities. The extract showed significant antihepatotoxic activity against carbon tetrachloride induced cytotoxicity in primary cultured rat hepatocytes. In antihyperliposis using aurothioglucose-induced obese mice, the extract suppressed significantly the increase in weights of body and liver, ameliorated triglyceride levels in the liver and serum, and also significantly reduced the

deposition of adipose tissue (Du et al., 2003).

Hepatoprotective aliphatic glycosides 3-(S)-3- $\beta$ -D-glucopyranosyloxybutanolide and its congener, 3-(S)-3- $\beta$ -D-glucopyranosyloxy-4-hydroxybutanoic acid were isolated as major constituents from whole plants of three *Goodyera* species, *G. schlechtendaliana* Reichb. fil., *G. matsumurana* Schltr. and *G. discolor* Ker-Gawl. Both compounds were found to have a hepatoprotective effect on liver injury induced by carbon tetrachloride in primary cultured rat hepatocytes (Du et al., 2000).

### Neuroprotective

$\beta$ -amyloid is strongly implicated in Alzheimer's pathology, and mitochondria play an important role in neurodegenerative disorders. Dactylorhin B is an active compound isolated from *Coeloglossum viride* (L.) Hartm. var. bracteatum (Willd.) and have neuroprotective effects. Abeta(25-35) directly disrupted mitochondrial function, inhibited key enzymes and contributed to apoptosis and deficiency of energy metabolism. Co-incubation of dactylorhin B attenuated Abeta (25-35)-induced pathological changes (Zhang et al., 2006b).

Alzheimer's disease is the most common cause of dementia in elderly. Recently, it has been reported that Alzheimer's disease is associated with cell death in neuronal cells including the hippocampus. Ethyl ether extracts of leaves *Gastrodia elata* Blume possess neuroprotective effect on neuronal cell death induced by amyloid beta-peptide in IMR-32 neuroblastoma cells (Kim et al., 2003a). Ischaemic stroke is a leading cause of death and long-lasting disability. Analysis of leaf extract of *G. elata* contains *p*-hydroxybenzyl alcohol (HBA) to which is an active ingredient. This compound was used to evaluate brain damage and transcriptional levels of protein disulfide isomerase (PDI) and 1-Cys peroxiredoxin (1-Cys Prx) genes known to play a role in antioxidant systems after transient focal ischemia in rat brain. HBA provide neuroprotection by preventing brain damage through increased expression of genes encoding antioxidant proteins after transient focal cerebral ischemia and may be effective as neuroprotective agents at the cellular and molecular levels in the brain (Yu et al., 2005). Hsieh et al. (1997) demonstrated that gastrodin and *p*-hydroxybenzyl alcohol can facilitate memory consolidation and retrieval, but not acquisition in rats. The facilitating effects of both compounds are different from those of piracetam as positive control. In another study the rhizome of *G. elata* prolonged the shortened step-through latency induced by scopolamine on the passive avoidance task. Gastrodin and *p*-hydroxybenzyl alcohol may be the active constituents (Wu et al., 1996).

The hydroalcoholic extract of rhizomes of *G. elata* showed antidepressant-like activity by means of behavioral models that included forced swimming, tail suspending and open-field tests (Zhou et al., 2006).

### Pain treatment

Pain is considered one of the most common complaints worldwide for which patients seek treatment. Conventional analgesic agents have played an important role in modern pain therapy, but they cause several adverse effects. Therefore, search for new and better analgesics agents continues. *Scaphyglottis livida*, a Mexican medicinal herb commonly employed for treatment of anti-inflammatory diseases and pain. The antinociceptive effect of methanol-chloroform extract of the plant was tested in male mice using the writhing test. In this test intraperitoneal administration of acetic acid (0.6%) provokes abdominal contractions, movements of the body as a whole (particularly of the hind paws), twisting of dorsoabdominal muscles, and reduction in motor activity. Reduction of stretching per unit of time was considered as antinociception. *S. livida* produced a significant reduction in the number of stretches in the acetic acid-induced writhing test (Déciga-Campos et al., 2007b). Other experiment reported with the oral administration extract of *Scaphyglottis livida* produced dose-dependent antinociceptive and anti-inflammatory effects when tested in mice and rats using the hot-plate and carrageenan-induced inflammation models. 5 $\alpha$ -Lanosta-24,24-dimethyl-9(11), 25-dien-3 $\beta$ -ol, cyclobalanone, gigantol and 3,4'-dihydroxy-3',4,5-trimethoxybibenzyl were isolated from extract of *Scaphyglottis livida*. 5 $\alpha$ -Lanosta-24,24-dimethyl-9(11),25-dien-3 $\beta$ -ol, and cyclobalanone showed significantly antinociceptive and anti-inflammatory activity (Déciga-Campos et al., 2007a). In a study made with methanol-chloroform extract of the whole plant *S. livida* produced a significant reduction in number of stretches in the acetic acid-induced writhing test (Deciga-Campos et al., 2005).

Methanol extract of *Maxillaria densa* reduced acetic acid-induced abdominal writhes but was not able to produce antinociception in hot-plate assay. Fimbrinol A and erianthridin isolated from active extract of *Maxillaria densa* partially reduced acetic acid-induced writhes. Results tend to support the popular use of this species in folk medicine for treatment of pain (Déciga-Campos et al., 2007a).

Pholidotin and 24-methylenecycloartenol isolated from *Epidendrum Mosenii* stems produced marked and dose-related inhibition of acetic acid-induced pain, inhibition of both phases of formalin-induced licking, inhibition of capsaicin-induced neurogenic pain, inhibition of capsaicin-induced neurogenic pain triterpenes of *E. mosenii* elicited pronounced antinociception (Ferreira et al., 2000). In another report triterpenes showed analgesic activity (Floriani et al., 1998).

### Antivirus

A series of four mannose (Man)-, three N-acetylglucosamine (GlcNAc)n-, ten N-

acetylgalactosamine /galactose(GalNAc/Gal)-, one 5-acetylneuraminic acid ( $\alpha$ -2,3-Gal/GalNAc)- and one 5-acetylneuroaminic acid( $\alpha$ -2,6-Gal/Gal-NAc)-specific plant agglutinins were evaluated for their antiviral activity *in vitro*. the mannose-specific lectins from orchid species *Cymbidium hybrid* (CA), *Epipactis helleborine* (EHA) and *Listera ovata* (LOA) were highly inhibitory to human immunodeficiency virus type 1 (HIV-1) and type 2 (HIV-2) in MT-4, and showed a marked anti-human cytomegalovirus (CMV), respiratory syncytial virus (RSV) and influenza A virus activity in HEL, HeLa and MDCK cells, respectively (Balzarini et al., 1992). The 50% effective concentration ( $EC_{50}$ ) of CA and EHA for HIV ranged from 0.04 to 0.08  $\mu$ g/ml, that is about 3 orders of magnitude below their toxicity threshold (50% inhibitory concentration for MT-4 cell growth: 54 to 60  $\mu$ g/ml). Unlike dextran sulfate, the plant lectins CA, EHA and UDA did not interfere with HIV-1 adsorption to MT-4 cells and RSV- and influenza A virus adsorption to HeLa and MDCK cells, respectively. However, they showed potent impact on dengue virus infection (Qiu et al., 2007, Balzarini et al., 1992).

In other study  $\alpha$ -(1-3)- and  $\alpha$ -(1-6)-D-mannose-specific plant lectins isolated from *Listera ovata* inhibited infection of MT-4 cells by human immunodeficiency virus types 1 and 2 (HIV-1 and HIV-2) and simian immunodeficiency virus at concentrations comparable to concentrations at which dextran sulfate (molecular weight, 5,000 [DS-5000]).  $\alpha$ -(1-3)-D-and  $\alpha$ -(1-6)-D-mannose-specific plant lectins interfere with an event in the HIV replicative cycle that is subsequent to attachment of the virions to the cells (Balzarini et al., 1991).

Two glucans were isolated from *Gastrodia elata*,  $\alpha$ -D-(1 $\rightarrow$ 4)-glucan with a  $\alpha$ -(1 $\rightarrow$ 4) linked branch attached to O-6 branch points with different branch degrees. These compounds coronaviruses are important human and animal pathogens, the relevance of which increased due to emergence of new human coronaviruses like SARS-CoV, HKU1 and NL63.

Together with toroviruses, arteriviruses, and roniviruses. Coronaviruses belong to the Nidovirales order. So far antivirals are unable to combat infections with viruses of this order. Therefore, various antiviral strategies to counter nidoviral infections are under evaluation as lectins, which bind to N-linked oligosaccharide elements of enveloped viruses, can be considered as a conceptionally new class of virus inhibitors. Lectins isolated from orchid *Cymbidium* sp. agglutinin (CA) strongly inhibited coronaviruses (transmissible gastroenteritis virus, infectious bronchitis virus, feline coronaviruses serotypes I and II, mouse hepatitis virus), arteriviruses (equine arteritis virus and porcine respiratory and reproductive syndrome virus) and torovirus (equine Berne virus).

Remarkably, serotype II feline coronaviruses and arteriviruses were not inhibited by PRM-A (Van der Meer et al., 2007).

## Relaxation

Gigantol and 3,7-dihydroxy-2,4-dimethoxyphenanthrene isolated from *Scaphyglottis livida* (Lindley) Schltr. Orchid induced a significant concentration-dependent relaxation of contractions evoked by noradrenaline in endothelium-intact and denuded rat aorta rings (Villalobos-Molina et al., 2006). *S. livida* has been reported to be rich in phenanthenes and bibenzyl compounds which include 3,4'-Dihydroxy-5,5'-dimethoxybibenzyl, batatacin III, coelonin, 3,7-dihydroxy-2,4-dimethoxyphenanthrene, and 3,7-dihydroxy-2,4,8-trimethoxyphenanthrene.

All compounds induced a concentration-dependent inhibition of the spontaneous contractions of rat ileum with potencies comparable or higher to that of papaverine. Relaxation evoked by compounds coelonin, 3,7-dihydroxy-2,4-dimethoxyphenanthrene, and 3,7-dihydroxy-2,4,8-trimethoxyphenanthrene was blocked by L-NAME, an inhibitor of nitric oxide synthase. It was also demonstrated that 3,4'-Dihydroxy-5,5'-dimethoxybibenzyl increased cyclic GMP content in rat ileum rings. 4'-dihydroxy-5,5'-dimethoxybibenzyl-induced elevation of cGMP was inhibited by L-NAME and ODQ, inhibitors of nitric oxide synthase and soluble guanylyl cyclase, respectively. These results indicate that nitric oxide/cGMP formation constitute the signaling pathway in spasmolytic action (Estrada et al., 1999).

Gastrol has been isolated from methanol extract of rhizomes of *Gastrodia elata*. This constituent showed relaxant effects on smooth muscle preparations isolated from guinea-pig ileum (Hayashi et al., 2002).

2,5-dihydroxy-3,4-dimethoxyphenanthrene, fimbriol-A, nudol, gymnopusin and erianthridin isolated from *Maxillaria densa* provoked a concentration-dependent inhibition of spontaneous contractions of rat ileum with potencies comparable to papaverine. In order to establish the mode of action of stilbenoids, their effect on contractions induced by different spasmogens (histamine, barium chloride) were investigated. In general, results suggested that the relaxant activity of the products does not involve a direct nitrenergic or antihistaminergic mode of action or an interference with calcium influx into smooth muscle cells. Two new phenanthrene derivatives, 2,5-dihydroxy-3, 4-dimethoxyphenanthrene and 9,10-dihydro-2,5-dihydroxy-3, 4-dimethoxyphenanthrene, were isolated from an extract prepared from whole plant of the orchid *Maxillaria densa* with spasmolytic activity. In addition, four known compounds, namely 2,7-dihydroxy-3, 4-dimethoxyphenanthrene, 9,10-dihydro-2,7-dihydroxy-3, 4-dimethoxyphenanthrene, 2,5-dihydroxy-3,4, 9-trimethoxyphenanthrene, and 2,7-dihydroxy-3,4, 9-trimethoxyphenanthrene, were obtained (Estrada et al., 1999a).

The combined methylene chloride and methanol (1:1) extract prepared from whole plant of *Nidema boothii* inhibited spontaneous contractions ( $IC_{50} = 6.26 \pm 2.5$   $\mu$ g/mL) of guinea-pig ileum. Bioassay-guided fractionation

of active extract led to isolation of aloifol II, gigantol, lusianthridin, and batatasin III were obtained. All compounds induced notable concentration-dependent inhibition of spontaneous contractions of guinea-pig ileum with  $IC_{50}$  values that ranged between 0.14 and 2.36  $\mu$ M. Results indicate that for maximum spasmolytic activity bibenzyls should have oxygenated substituents on both aromatic rings; on the other hand, methylation of free hydroxyl groups as well as increment of oxygenated groups in relation to compounds gigantol and batatasin III decreased smooth muscle relaxant activity. It was also demonstrated that bibenzyls might exert their spasmolytic action not only by a nitrenergic mechanism but also by inhibiting CaM-mediated processes (Hernández-Romero et al., 2004).

### Anti-platelet aggregation

*Dendrobium* species have been commonly used in traditional Chinese medicine as tonic. Methanol extract of stem of *Dendrobium loddigesii* was found to inhibit aggregation of rabbit platelets induced by arachidonic acid and collagen. Moscatilin moscatin and moscatilin diacetate isolated from this plant exhibited antiplatelet aggregation activity (Chen et al., 1994). Same observations have been made in other experiment when moscatilin, homoeriodictyol, scoparone, scopoletin and gigantol were identified from stems of *D. densiflorum* Lindl. ex Wall were found to exhibit anti-platelet aggregation activity *in vitro*. Among them, scoparone has been reported to possess potent anti-platelet aggregation activity before and was used as positive control (Fan et al., 2001).

Bioactivity-directed separation led to identification of 3,7-dihydroxy-2,4-dimethoxyphenanthrene, 3-methylgigantol, and erianthridin from the ethanolic extract of *Ephemerantha lonchophylla*. Antiplatelet tests were carried out using 4 different aggregation inducers, viz. arachidonic acid (AA), thrombin, collagen and platelet activating factor (PAF). Results indicate that these compounds exhibited significant anti-aggregation activities against AA-induced aggregation being most effective. Estimated  $IC_{50}$  values in this regard for were 24, 30 and 9  $\mu$ M respectively (Chen et al., 2000).

A polysaccharide isolated from methanol extract of rhizomes of *Gastrodia elata* exhibited inhibition of platelet aggregation and antithrombosis activity (Ding et al., 2007).

### Miscellaneous

#### Allergen/antiallergic

Sensitizing properties of this ornamental orchid (*Cymbidium* sp.) were demonstrated by experimental sensitization of guinea pigs. Chemical analysis of ether

extracts disclosed the presence of quinone 2,6-dimethoxy-1,4-benzoquinone, its role as a contact allergen is emphasized, as it has been found in more than 50 different plant and wood species (Hausen et al., 1984).

Methanol extract from the tubers of *Gymnadenia conopsea* showed an antiallergic effect on ear passive cutaneous anaphylaxis reactions in mice. From the methanol extract, gymconopins A, B, gymconopin D, and 3,3'-Dihydroxy-2,6-bis(4-hydroxybenzyl)-5-methoxybibenzyl were isolated. These compounds inhibit antigen-induced degranulation by 65.5 - 99.4% at 100  $\mu$ M in RBL-2H3 cells (Matsuda et al., 2004).

#### Antipyretic

Methanol extract from rhizomes of *Dendrobium moniliforme* showed antipyretic action in rabbits (Chen and Chen, 1935).

#### Inhibitors of $Na^+$ , $K^+$ -ATPase

From fresh stem of *Dendrobium loddigesii* Rolfe three constituents were isolated and identified. They are shihunidine, shihunine and dendrophenol. Shihunidine and shihunine were shown to be inhibitors of  $Na^+$ ,  $K^+$ -ATPase of the rat kidney (Li et al., 1991).

#### Immunomodulatory activity

Sesquiterpene glycosides with alloaromadendrane, emmotin, and picrotoxane type aglycones were isolated from stems of *Dendrobium nobile* Lindl (Orchidaceae). Their compounds showed immunomodulatory activity (Ye et al., 2002).

#### Antimutagenic activity

Moscatilin also was obtained from *Dendrobium nobile*, this bibenzyl compound possesses antimutagenic activity on some mutagen such as furylfuramide, 4-nitroquinoline-1-oxide (4NQO), N-methyl-N'-nitro-N-nitrosoguanidine, UV irradiation, 3-amino-1,4-dimethyl-5H-pyrido[4,3b]indole (Trp-P-1), benzo[a]pyrene (B[a]P), and aflatoxin B(1), (Miyazawa et al., 1999).

#### Endurance capacity

*A. formosanus* activated utilization of lipid more than glucose as the energy source for performance. Treatment also significantly decreased fat accumulation (Ikeuchi et al., 2005).

### **Modulatory**

Compounds isolated from *Gastrodia elata* such as 4-hydroxybenzaldehyde and 4-hydroxy-3-methoxybenzaldehyde inhibited potently the activity of GABA transaminase while activity of another constituent, 4-hydroxybenzyl alcohol, was very weak (Ha et al., 2001).

### **Pharmacogenomic**

Herbal extract of *Anoectochilus formosanus* (AF), a popular folk medicine with anticancer activity. Pharmacogenomic activities of this plant extract as a crude phytocompound mixture were compared to those plumbagin. A similar level of complexity in transcriptional regulation at the genomic level was observed for both extract- and plumbagin-treated MCF-7 cells, as revealed by the number of up- or downregulated genes as well as by specific but distinct patterns found in the gene-clustering analysis (Yang et al., 2004).

### **Ameliorative**

Aqueous extract of *A. formosanus* (AFE) showed effect on osteopenia in ovariectomized (OVX) rats. In OVX rats, the increases of body weight and serum total cholesterol were significantly decreased by AFE or 17 $\beta$ -estradiol treatment. In OVX rats, atrophy of uterus and vagina was preserved by treatment with 17 $\beta$ -estradiol, but not by AFE. Decreased weight of pituitary was increased by treatment with both 17 $\beta$ -estradiol and AFE. There were decreases in bone density and calcium content including the right femur and the fourth lumbar vertebra, when compared with the sham control rats. Treatment with either 17 $\beta$ -estradiol or AFE ameliorated these changes induced by OVX. In addition, ovariectomy increased serum alkaline phosphatase levels. Increases were suppressed by treatment with 17 $\beta$ -estradiol and AFE. Results demonstrate that AEF could ameliorate ovariectomy-induced osteopenia (Shih et al., 2001). In another study *A. formosanus* reduced weights of body and liver, and also decreased triglyceride level. Kinsenoside, which was isolated from *A. formosanus*, had no effect for anti-hyperliposis, in aurothioglucose-induced obese mouse (Du et al., 2001).

### **Anthelmintic**

Ethyl ether from tuber of *Bletilla striata* which grows Gangweon-do of the Korea peninsula has anthelmintic activity *in vitro* on the cercaria, the excysted metacercaria and adult of *Clonorchis sinensis* (Rhee et al., 1982).

### **Endothelial cells proliferation**

A polysaccharide was isolated from traditional Chinese medicinal herb, *Bletilla striata* (Thunb.) Reichb. f. It induces endothelial cells proliferation and vascular endothelial growth factor expression *in vitro* (Wang et al., 2006, Chang, 1996). However, was proved on adhesion of human umbilical venous endothelial cells (HUVECs), promotes the adhesion of HUVECs but not with a doses - dependent manner *in vitro* (Sun et al., 2005).

### **Anti-aging**

Extract of *Coeloglossum viride* (L) Hartm. var. bracteatum (Willd) Richter showed anti-aging effects on senescent model mice induced by D-galactose and sodium nitrite. Improve memory dysfunction induced by consecutive injection of D-galactose and sodium nitrite, and has nootropic and antiaging effects (Zhang et al., 2005). Previous studies have shown that injection of D-galactose could result in senescent performances in animals, that injection of NaNO<sub>2</sub> could cause ischaemia and hypoxia in many organs. D-galactose and NaNO<sub>2</sub> treated mice had significant deficits in learning and memory function. Treatment of *C. viride* ameliorated memory impairment; rectified the biochemistry and neural system changes in mice (Zhang et al., 2006a). Zhang et al., (2006b) demonstrated that administration of *C. viride* for 14 days significantly improved cognitive deficits and biochemical markers catalase activity and lipid oxidation (evaluated as MDA) are markers of oxidative stress, GST activity is related to conjugation of organic compounds and superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) activities and also reduced histological lesions in mouse brain. *C. viride* can worth for senescence and dementia.

### **Gastric**

Aquous extract of leaves of *Dendrobium nobile* produced a variations in gastric acidity output, serum gastrin and plasma somatostatin concentration. It also showed a significant increase in both acidity output and serum gastrin concentration. No significant change occurred in plasma somatostatin concentration (Chen et al., 1995). Experiments were conducted to study the effect of dendrobine (3 x 10<sup>-5</sup> M) isolated from leaves of *D. nobile* which reduced  $\beta$ -alanine and taurine-induced depolarizations of primary afferent terminals, while having little effect upon GABA- and glycine-induced depolarizations. Dendrobine (10<sup>-5</sup> M) reversibly blocked presynaptic inhibition caused by antidromic conditioning stimulation of the ventral root. These effects of dendrobine were qualitatively similar to those of strychnine but were somewhat different from those of



microtoxinin, a molecule having the same picrotoxane skeleton (Kudo et al., 1983).

Pretreated with *Gastrodia elata* Blume in a mouse water immersion restraint (WIR) stress-induced gastric lesion model had significantly fewer gastric lesions than their respective controls. Moreover, *G. elata*-treated mice showed significant decreases in serum and gastric nitric oxide levels. These findings collectively suggest that *G. elata* significantly protects gastric mucosa against WIR-induced gastric damage, at least in part by decreasing NO levels via suppression of iNOS mRNA expression (An et al., 2007).

### **Herbicidal agent**

A whole plant chloroform-methanol (1:1) extract of *Epidendrum rigidum* orchid inhibited radicle growth of *Amarantus hypochondriacus* (IC<sub>50</sub> = 300 µg/mL) showed significant phytotoxicity activity. Bioassay-guided fractionation of active crude extract leads to isolation of stilbenoids gigantol, and batatasin III, 2,3-dimethoxy-9,10-dihydrophenanthrene-4,7-diol and 3,4,9-trimethoxyphenanthrene-2,5-diol inhibited radicle growth of *A. hypochondriacus* with IC<sub>50</sub> values of 0.65, 0.1, 0.12, and 5.9 µM, respectively. Phytotoxic effect was greater (2:9) or lower (1: 11) than that of 2,4-dichlorophenoxyacetic acid (IC<sub>50</sub> = 0.19 µM) used as positive control. Thus, apparently, bibenzyl and phenanthrene derivatives are the main phytotoxic principles of the plant (Hernandez-Romero et al., 2005).

### **Lipoprotein oxidation**

One dihydrostilbene (3-methylgigantol) and three phenanthrene (Ephemeranthone, denbinobin and 3-ethoxy-5-hydroxy-7-methoxy-1,4-phenanthraquinone) were isolated from an ethanol extract of rhizomes of the Chinese herbal *Ephemerantha lonchophylla*. Ephemeranthone inhibiting human low density lipoprotein oxidation *in vitro* was active 5.3 times that of probucol (Chen et al., 1999).

Recently, habenariol was isolated from freshwater orchid, *Habenaria repens*. Habenariol inhibiting lipid peroxidation of human low density lipoprotein (LDL) (Johnson et al., 1999).

### **Maturation**

*A. formosanus* treatment significantly increased fetal lung/body weight ratio, as compared to dexamethasone treatment. Saturated phosphatidylcholine levels in fetal lung tissue and growth hormone levels in maternal serum were significantly increased in the *A. formosanus*- and dexamethasone-treated groups as compared to controls.

Antenatal *A. formosanus* treatment may play a role in accelerating fetal rat lung maturation (Chen et al., 2004).

### **Phytoalexin**

Coeloginanthridin, a 9,10-dihydrophenanthrene derivative, and coeloginanthrin, the corresponding phenanthrene analogue, was isolated from *Coelogyne cristata* orchid. In light of earlier reports on structurally similar compounds, coeloginanthridin and coeloginanthrin may have biological activities of phytoalexins and endogenous plant growth regulators (Majumder et al., 2001).

### **Skin blood flow**

Methanol extracts from *Calanthe discolor* LINDL. and *C. liukiensis* SCHLTR. were found to exhibit hair restoring and skin blood flow promoting activities. Through bioassay-guided separation using skin blood flow increasing effect, a novel indole S,O-bisdesmoside, calanthoside, was isolated together with three new components, glucoindican, calaliukienoside, and calaphenanthrenol, and known compounds such as tryptanthrin, indirubin, isatin, and indicant, and they showed an activating effect on skin blood flow (Yoshikawa et al., 1998).

### **Wound healing**

In other study *Vanda roxburghii* ethanol extracts have effect on wound healing, using excision wound model. Significant increases in wet and dry granulation tissue weights, hydroxyproline, and hexosamine contents were detected. Pro-healing action may be attributed either to increased collagen deposition or to better alignment and maturation or both (Nayak et al., 2005).

## **CLINICAL TRIALS**

### **Embolizing agent**

Zheng et al. (1998) demonstrated that *Bletilla striata* is a good vascular embolizing agent for treating of primary hepatic carcinoma. In another study 56 cases of hepatic carcinoma were treated with *Bletilla striata* by hepatic artery embolization, with conventional gelform embolization in 50 cases as control. Embolization with *Bletilla striata* led to extensive and permanent vascular obstruction, accompanied with marked shrinkage of tumor size and significant decrease in serum AFP levels. *B. striata* is an ideal vascular embolizing agent (Zheng et al., 1996). Experiments were conducted to study the

**Table 2.** Alkaloids and nitrogen compounds isolated from Orchids.

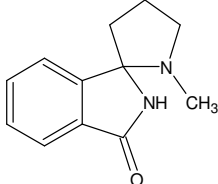
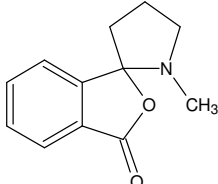
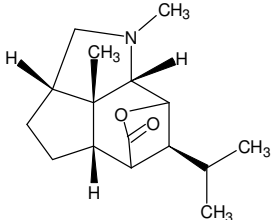
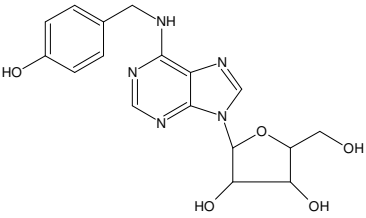
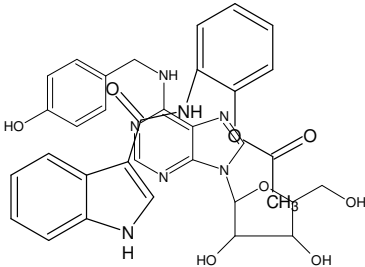
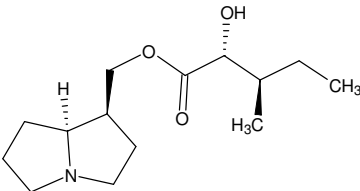
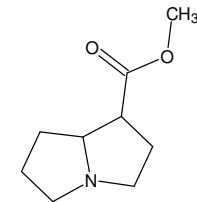
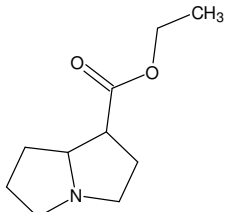
Structure	Source	Activities
 <p>Shihunidine</p>	Stem of <i>Dendrobium loddigesii</i> (Li et al., 1991).	Shown to be inhibitors of Na <sup>+</sup> , K <sup>+</sup> -ATPase of the rat kidney (Li et al., 1991).
 <p>Shihunine</p>	Stem of <i>Dendrobium loddigesii</i> (Li et al., 1991).	Shown to be inhibitors of Na <sup>+</sup> , K <sup>+</sup> -ATPase of the rat kidney (Li et al., 1991).
 <p>Dendrobine</p>	<i>Dendrobium nobile</i> (Kudo et al., 1983). <i>Dendrobium moniliforme</i> (Chen and Chen, 1935)	Reduced the β-alanine- and taurine-induced depolarizations of primary afferent terminals, while having little effect upon GABA- and glycine-induced depolarizations (Kudo et al., 1983). Showed antipyretic action in rabbits (Chen and Chen, 1935)
 <p>N<sup>6</sup>-(4-hydroxybenzyl)adenine riboside</p>	<i>Gastrodia elata</i> (Huang et al., 2007).	Exhibited in preventing PC12 cell apoptosis induced by serum deprivation through suppression of the JNK pathway (Huang et al., 2007).
 <p>Cephalandole B</p>	<i>Cephalanceropsis gracilis</i> (Wu et al., 2006)	Showed significant cytotoxicity (Wu et al., 2006)
 <p>Cremastrine</p>	<i>Cremastra appendiculata</i> (Ikeda et al., 2005)	Showed selective inhibition of the muscarinic M3 receptor (Ikeda et al., 2005)

Table 2. Contd

	<i>Chysis bractescens</i> (Luning and Trankner, 1965)
Chysin A	
	<i>Chysis bractescens</i> (Luning and Trankner, 1965)
Chysin B	

effect on 106 cases of primary liver cancer were treated by temporary or permanent hepatic arterial embolization with *Bletilla striata* powders (permanent, 56 cases) or gelfoam powders (temporary, 50 cases) under controlled technical conditions, in term of degree of tumor necrosis, revascularization of tumor, and long-term effect, the result is superior to gelfoam as an embolizing agent for hepatic carcinoma. *Bletilla striata* and gelfoam were used as embolizing agents for embolization of various hepatotropic vessels in dogs. Results proved that *Bletilla striata* was superior to gelfoam. Mechanisms of embolization by *Bletilla striata* are attributable to following factors: non-absorbent property, mechanical obstruction; effects on coagulative and anticoagulative systems and secondary obstruction resulted from the injury to wall of blood vessels (Feng et al., 1995).

## CHEMICAL CONSTITUENTS

Pharmacologically most studied chemical component in Orchids are mainly alkaloids, bibenzyl derivatives, flavonoids, phenanthrenes and terpenoids which are present in leaves, roots, flowers and whole plant. These are summarized, with their structures, in Tables 2 - 7.

## CONCLUSION

Orchids are ancient plants with an illustrious ornamental history and have been the subject of classical reviews for over 100 years. However, until only very recently, importance of the plants has been largely overlooked. Pharmacological studies conducted on Orchids indicate

the immense potential of these plants in treatment of conditions such as neurodegenerative disorders, anticonvulsive, anticancer, antidiabetic, etc. However, gaps in studies conducted are apparent which need to be bridged in order to exploit full medicinal potential of Orchids.

Since most drugs containing Orchids that are available in the market are in the form of polyherbal formulations, it is difficult to attribute a particular medicinal action as being solely due to Orchids component of the drug. Aside from possible synergistic effects existing among plant extract constituents, another likelihood could be formation of 'pro-drugs' which are defined as compounds activated in the body after administration of a particular medicine. Due to the non-availability of commercial standards, most studies first involve extraction and purification of the active principle to be used as a reference standard which makes the process more cumbersome.

Orchids are popular medicinal plants. It has recently been proved to be a rich storehouse of chemical constituents with promising anti-tumor and anti-inflammatory activities as revealed in modern biology-based studies. Investigations in progress may identify new molecules that confirm usefulness of traditional remedies to develop new therapeutics. Orchid's species have recently been a hot target of many investigations related to the chemical, biological, pharmacological, and medical properties of these plants. Results from these investigations clearly show that there is a strong relationship between the ethnopharmacological use of these plants and medicinal properties of important compounds identified from them.

The possibility of rapid micropropagation of the plants is an added advantage. Traditional use of orchids in

**Table 3.** Bibenzyl derivatives isolated from Orchids.

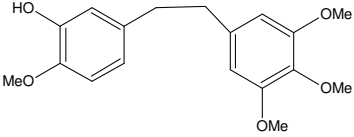
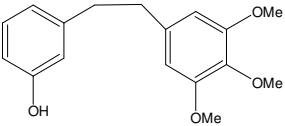
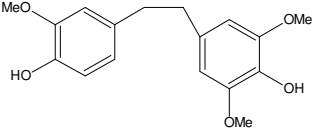
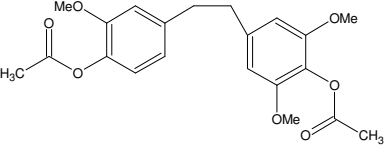
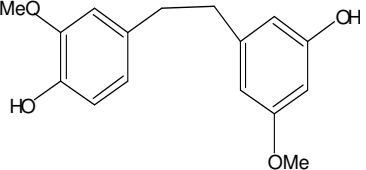
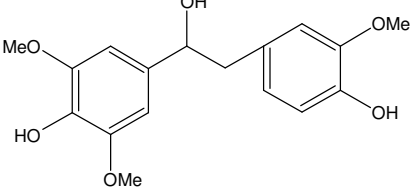
Structure	Source	Activities
Alkyl ferulates	Methanolic extract of <i>Dendrobium moniliforme</i> (Lo et al., 2004).	Showed antioxidant activity (Lo et al., 2004).
 <p>Erianin</p>	<i>Dendrobium chrysotoxum</i> (Gong et al., 2004)	Caused moderate growth delay in human hepatoma Bel7402 and melanoma A375 and induced significant vascular shutdown. Erianin displayed potent anti-angiogenic activities (Gong et al., 2004)
 <p>Isoamoenylin</p>	<i>Dendrobium amoenum</i> (Venkateswarlu et al., 2002).	Showed moderate antioxidative and weak antibacterial activities (Venkateswarlu et al., 2002).
 <p>Moscatilin</p>	MeOH extract of the stem of <i>Dendrobium loddigesii</i> (Chen et al., 1994).	Inhibit the aggregation of rabbit platelets induced by arachidonic acid and collagen (Chen et al., 1994). Also demonstrated a hard suppression of the mutagenicity (Miyazawa et al., 1999).
 <p>Moscatilin diacetato</p>	MeOH extract of the stem of <i>Dendrobium loddigesii</i> Chen et al. (1994).	Inhibit the aggregation of rabbit platelets induced by arachidonic acid and collagen (Chen et al., 1994). Is efficacy as anticancer agent (Ho and Chen, 2003).
 <p>Gigantol</p>	<i>Cymbidium goeringii</i> (Won et al., 2006), <i>Epidendrum rigidum</i> (Hernandez-Romero et al., 2005), and <i>Scaphyglottis livida</i> (Déciga-Campos et al., 2007a).	Inhibits the LPS-induced iNOS and COX-2 expression via NF-kappaB inactivation in RAW 264.7 macrophages cells. (Won et al., 2006). Inhibited radicle growth of <i>Amaranthus hypochondriacus</i> (IC50 0.65 μM) (Hernandez-Romero et al., 2005).
 <p>Nobilin D</p>	<i>Dendrobium nobile</i> (Zhang et al., 2007).	Displayed higher antioxidant activity than vitamin C (Zhang et al., 2007).

Table 3. Contd

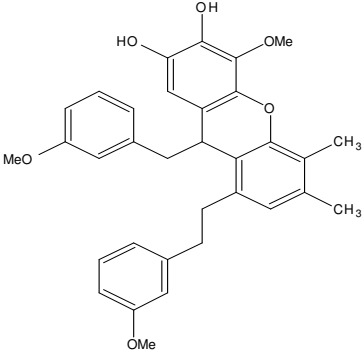
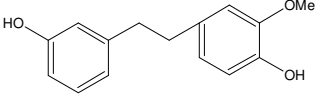
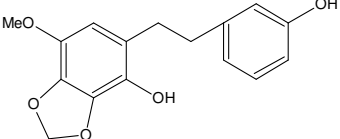
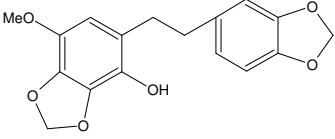
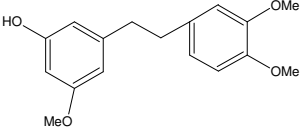
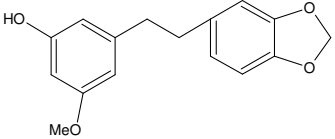
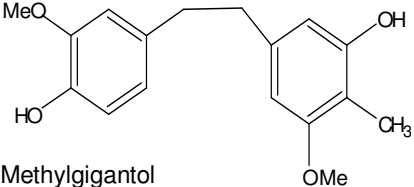
 <p>Nobilin E</p>	<i>Dendrobium nobile</i> (Zhang et al., 2007).	Displayed higher antioxidant activity than vitamin C (Zhang et al., 2007).
 <p>Batatasin III</p>	<i>Epidendrum rigidum</i> (Hernandez-Romero et al., 2005)	Inhibited radicle growth of <i>Amaranthus hypochondriacus</i> (IC <sub>50</sub> 0.65 μM) (Hernandez-Romero et al., 2005).
 <p>Pholidotol A</p>	<i>Pholidota chinensis</i> (Wang et al., 2006).	Inhibited Nitric oxide (NO) production with an IC <sub>50</sub> value at 24.3 μM, respectively (Wang et al., 2006).
 <p>Pholidotol B</p>	<i>Pholidota chinensis</i> (Wang et al., 2006).	Inhibited Nitric oxide (NO) production with an IC <sub>50</sub> value at 17.1 μM, respectively (Wang et al., 2006).
 <p>Cumulatin</p>	<i>Bulbophyllum kwangtungense</i> (Wu et al., 2006).	Exhibited anti-tumor activities against Hela and K562 human tumor cell lines (Wu et al., 2006).
 <p>Densiflorol A</p>	<i>Bulbophyllum kwangtungense</i> (Wu et al., 2006).	Exhibited anti-tumor activities against Hela (IC <sub>50</sub> = 79.4 μM) and K562 human tumor cell lines (IC <sub>50</sub> = 67.6 μM) (Wu et al., 2006).
 <p>3-Methylgigantol</p>	<i>Ephemerantha lonchophylla</i> (Chen et al., 2000)	Exhibited significant anti-aggregation activities (Chen et al., 2000)

Table 3. Contd

	<p><i>Nidema boothii</i> (Hernández-Romero et al., 2004)</p>	<p>Showed spasmolytic action (Hernández-Romero et al., 2004)</p>
<p>Aloifol</p>	<p><i>Gymnadenia conopsea</i> (Matsuda et al., 2004)</p>	<p>Inhibit the antigen-induced degranulation (Matsuda et al., 2004)</p>
	<p><i>Gymnadenia conopsea</i> (Matsuda et al., 2004)</p>	<p>Inhibit the antigen-induced degranulation (Matsuda et al., 2004)</p>
<p>Gymconopin D</p>	<p>Dihydroxy-2,6-bis(4-hydroxybenzyl)-5-methoxybibenzyl</p>	

Table 4. Flavonoids isolated from Orchids.

Structure	Source	Activities
	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (He et al., 2006)</p>	<p>Antioxidant activity (He et al., 2006; Gamez, et al., 1998)</p>
<p>Quercetin-7-O-β-D-[6''-O-(trans-feruloyl)]-glucopyranoside</p>		

Table 4. Contd

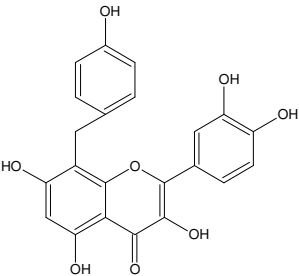
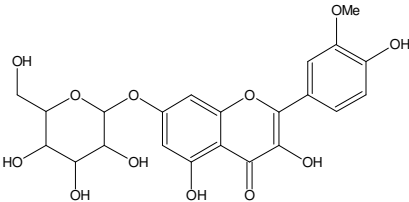
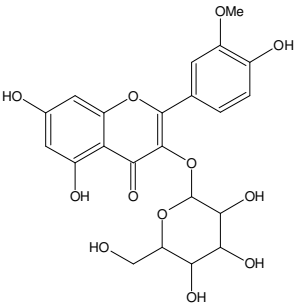
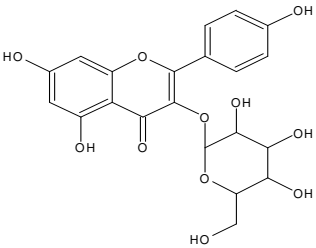
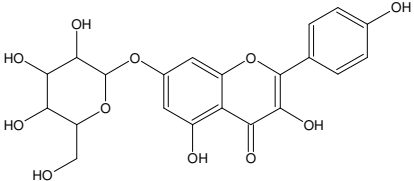
 <p>The structure shows a quercetin core with a p-hydroxybenzyl group attached to the C-8 position of the flavone ring.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (Merghem et al., 1995)</p>
<p>8-C-p-hydroxybenzylquercetin</p>	
 <p>The structure shows a quercetin core with a 3,4,5-trimethoxybenzyl group attached to the C-8 position of the flavone ring.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (He et al., 2006)</p>
<p>8-C-3,4,5-trimethoxybenzylquercetin</p>	
 <p>The structure shows isorhamnetin (a flavone with a 3,4,5-trimethoxyphenyl group at C-6) linked to a beta-D-glucopyranoside moiety at the C-7 position.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (He et al., 2006)</p>
<p>Isorhamnetin-7-O-β-D-[glucopyranoside</p>	
 <p>The structure shows isorhamnetin linked to a beta-D-glucopyranoside moiety at the C-3 position.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (Markham et al., 1978)</p>
<p>Isorhamnetin-3-O β-D-[glucopyranoside</p>	
 <p>The structure shows kaempferol (a flavone with a 3,4-dihydroxyphenyl group at C-6) linked to a beta-D-glucopyranoside moiety at the C-3 position.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (Gong, 1986)</p>
<p>Kaempferol-7β-D-[glucopyranoside</p>	

Table 4. Contd

<p>The structure shows a flavonol core with a hydroxyl group at C5 and three methoxy groups at C3', C4', and C7'. The C3 position is linked to a rutinoside sugar moiety.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (Ja et al., 2002)</p>	
<p>5-Hydroxy-3',4',7-trimethoxyflavonol-3-β-D-[rutinoside]</p>		
<p>The structure shows a flavonol core with hydroxyl groups at C5 and C7, and a methoxy group at C3'. The C3 position is linked to a rutinoside sugar moiety.</p>	<p>Ethanollic extract from whole plant <i>Anoectochilus roxburghii</i> (Victoire et al., 1988)</p>	
<p>Isorhamnetin-3-β-D-[rutinoside]</p>		
<p>The structure shows a flavonol core with hydroxyl groups at C3, C5, C7, and C3'.</p>	<p>Methanolic extract of <i>Dendrobium tosaense</i> (Lo et al., 2004).</p>	<p>Antioxidant activity (Lo et al., 2004)</p>
<p>Quercetin</p>		
<p>The structure shows a flavone core with hydroxyl groups at C5 and C7, and a phenyl group at C2.</p>	<p><i>Cypripedium macranthos</i> (Shimura et al., 2007)</p>	<p>Showed antifungal activity (Shimura et al., 2007)</p>
<p>Chrysin</p>		
<p>The structure shows a flavone core with hydroxyl groups at C5 and C7, a methoxy group at C3', and a 3,4-dihydroxyphenyl group at C2.</p>	<p><i>Dendrobium densiflorum</i> (Fan et al., 2001)</p>	<p>Exhibit anti-platelet aggregation activity <i>in vitro</i> (Fan et al., 2001)</p>
<p>Homoeriodictyol</p>		



Table 4. Contd

	<i>Spiranthes australis</i> (Peng et al., 2007)	Exhibited high-inhibition effect on tumor cells growth. A dose > 15 µg/ml the cancer cells were totally inhibited, especially to K562 cancer cell (IC <sub>50</sub> < 1.0 µg/ml) (Peng et al., 2007)
<p>(2S)-5,2',6'-trihydroxy-6-lavandulyl-4''-(γ, γ-dimethylallyl)-2'',2''-dimethylpyrano-[5'',6'':7,8]-flavanone</p>	<i>Cremastra appendiculata</i> (Shim et al., 2004)	Is a potent inhibitor of angiogenesis (Shim et al., 2004)
<p>Homoiso flavanone</p>		

Table 5. Phenanthrenes isolated from Orchids.

Structure	Source	Activities
	<i>Coelogyne cristata</i> (Majumder et al., 2001)	May have biological activities of phytoalexins and endogenous plant growth regulators (Majumder et al., 2001)
<p>Coeloginanthridin</p>	<i>Coelogyne cristata</i> (Majumder et al., 2001)	May have biological activities of phytoalexins and endogenous plant growth regulators (Majumder et al., 2001)
	MeOH extract of the stem of <i>Dendrobium loddigesii</i> (Chen et al., 1994)	Inhibit the aggregation of rabbit platelets induced by arachidonic acid and collagen (Chen et al., 1994). Is efficacy as anticancer agent (Ho and Chen, 2003).
<p>Coeloginanthrin</p>		
<p>Moscatin</p>		

Table 5. Contd

	<i>Cypripedium macranthos</i> (Shimura et al., 2007)	Showed antifungal activity (Shimura et al., 2007)	
Lusianthrin	<i>Ephemerantha lonchophylla</i> (Chen et al., 1999)	Showed antioxidant activity. Inhibiting human low density lipoprotein oxidation in vitro was active 5.3 times that of probucol (Chen et al., 1999)	
	Ephemeranthone	<i>Maxillaria densa</i> (Déciga-Campos et al., 2007a)	Showed anti-inflammatory activity (Déciga-Campos et al., 2007a). Showed inhibition of the tone and amplitude of the spontaneous contractions of the rat ileum (Strada et al., 2004)
	Fimbrinol A	<i>Maxillaria densa</i> (Déciga-Campos et al., 2007), <i>Ephemerantha lonchophylla</i> (Chen et al., 2000)	Showed anti-inflammatory activity (Déciga-Campos et al., 2007). Exhibited significant anti-aggregation activities (Chen et al., 2000)
	Erianthridin	<i>Dendrobium nobile</i> (You et al., 1995),	Cytotoxic against A549 (human lung carcinoma), SK-OV-3 (human ovary adenocarcinoma), and HL-60 (human promyelocytic leukemia) cell lines. Also showed antitumor activity on the life span of ICR mice intraperitoneally implanted (You et al., 1995)
4,7-Dihydroxy-2-methoxy-9,10-dihydrophenanthrene		<i>Dendrobium nobile</i> (You et al., 1995).	Cytotoxic against A549 (human lung carcinoma), SK-OV-3 (human ovary adenocarcinoma), and HL-60 (human promyelocytic leukemia) cell lines (You et al., 1995)
Denbinobin			

Table 5. Contd

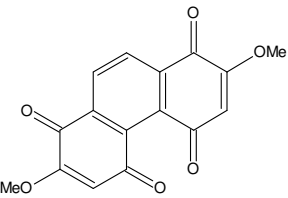
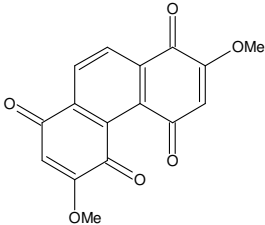
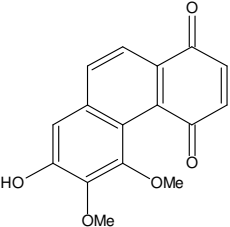
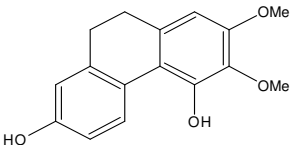
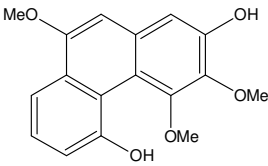
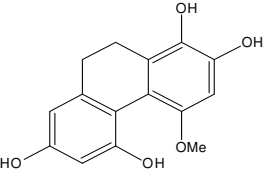
	<i>Dendrobium moniliforme</i> (Lin et al., 2001)	Showed potent antiinflammatory activity <i>in vitro</i> (Lin et al., 2001)
Moniliformin		
	<i>Dendrobium moniliforme</i> (Lin et al., 2001).	Showed potent anti-inflammatory activity <i>in vitro</i> (Lin et al., 2001).
2,6-Dimethoxy-1,4,5,8-phenanthradiquinone		
	<i>Dendrobium moniliforme</i> (Bae et al., 2004)	Inhibited VHR dual-specificity protein tyrosine phosphatase (DS-PTPase) activity (Bae et al., 2004).
7-Hydroxy-5,6-dimethoxy-1,4-phenanthrenequinone		
	<i>Epidendrum rigidum</i> (Hernandez-Romero et al., 2005)	Inhibited radicle growth of <i>Amaranthus hypochondriacus</i> (IC <sub>50</sub> 0.12 μM) (Hernandez-Romero et al., 2005)
2,3-Dimethoxy-9,10-dihydrophenanthrene-4,7-diol		
	<i>Epidendrum rigidum</i> (Hernandez-Romero et al., 2005)	Inhibited radicle growth of <i>Amaranthus hypochondriacus</i> (IC <sub>50</sub> 5.9 μM) (Hernandez-Romero et al., 2005).
3,4,9-Trimethoxyphenanthrene-2,5-diol		
	<i>Bletilla formosana</i> (Lin et al., 2005)	
4-Methoxy-9,10-dihydrophenanthrene-1,2,7-triol,		

Table 5. Contd

	<i>Bletilla formosana</i> . (Lin et al., 2005)	
1-(4-Hydroxybenzyl)-4,7-dimethoxy-9,10-dihydrophenanthrene-2-ol		<i>Bletilla formosana</i> . (Lin et al., 2005).
1,3,6-tri(4-Hydroxybenzyl)-4-methoxydihydrophenanthrene-2,7-diol		<i>Maxillaria densa</i> (Estrada et al., 1999). Showed spasmolytic activity (Estrada et al., 1999).
2,5-Dihydroxy-3,4-dimethoxyphenanthrene		<i>Maxillaria densa</i> (Estrada et al., 1999). Showed spasmolytic activity (Estrada et al., 1999).
9,10-Dihydro-2,5-dihydroxy-3,4-dimethoxyphenanthrene		<i>Bulbophyllum kwangtungense</i> (Wu et al., 2006). Exhibited anti-tumor activities against Hela and K562 human tumor cell lines (Wu et al., 2006).
Plicatol B		

Table 5. Contd

	<i>Maxillaria densa</i> (Estrada et al., 2004)	Showed inhibition of the tone and amplitude of the spontaneous contractions of the rat ileum (Estrada et al., 2004)
<p>Nudol</p>		
	<i>Maxillaria densa</i> (Estrada et al., 2004)	Showed inhibition of the tone and amplitude of the spontaneous contractions of the rat ileum (Estrada et al., 2004)
<p>Gymnopusin</p>		
	<i>Maxillaria densa</i> (Estrada et al., 2004)	Showed inhibition of the tone and amplitude of the spontaneous contractions of the rat ileum (Estrada et al., 2004)
<p>Erianthridin</p>		
	<i>Dendrobium chrysotoxum</i> (Yang et al., 2006).	Showed anti-inflammatory activity (Yang et al., 2006).
<p>Dendrochrysanene</p>		
	<i>Coelogyne ochracea</i> (Bhaskar et al., 1991)	
<p>Ochrone A</p>		
	<i>Agrostophyllum callosum</i> (Majumder et al., 2003)	
<p>Callosuminin</p>		

Table 5. Contd

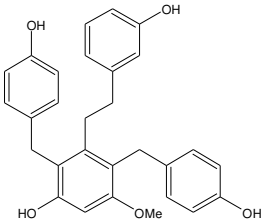
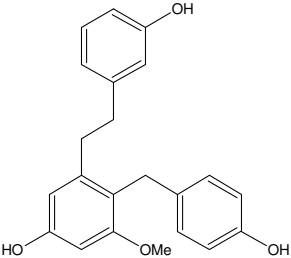
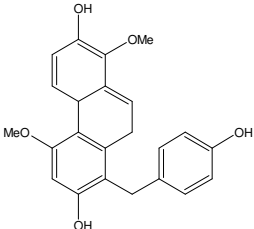
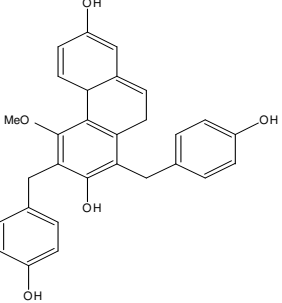
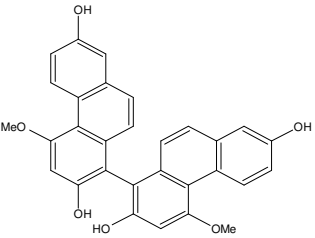
	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 10μM (Morita et al., 2005)
3,3'-Dihydroxy-2',6'-bis(p-hydroxybenzyl)-5-methoxybibenzyl	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 10μM (Morita et al., 2005)
	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30μM (Morita et al., 2005)
3',5-Dihydroxy-2-(p-hydroxybenzyl)-3-methoxybibenzyl	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30μM (Morita et al., 2005)
	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30μM (Morita et al., 2005)
1-(p-Hydroxybenzyl)-4,8-dimethoxyphenanthrene-2,7-diol	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30μM (Morita et al., 2005)
	2,7-Dihydroxy-1,3-bis(p-hydroxybenzyl)-4-methoxy-9,10-dihydrophenanthrene	<i>Bletilla striata</i> (Morita et al., 2005)
	Blestriarene B	

Table 5. Contd

	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30 μM (Morita et al., 2005)
Blestriarene C		
	<i>Bletilla striata</i> (Morita et al., 2005)	Showed inhibitory effect of tubulin polymerization at IC <sub>50</sub> 30 μM (Morita et al., 2005)
Blestrianol A		
	<i>Nidema boothii</i> (Hernandez-Romero et al., 2004)	Showed spasmolytic effect (Hernandez-Romero et al., 2004)
Lusianthridin		
	<i>Pholidota yunnanensis</i> (Guo et al., 2007)	Showed DPPH free radical scavenging activity (Guo et al., 2007)
2,4,7-Trihydroxy-9,10-dihydrophenanthrene		
	<i>Pholidota yunnanensis</i> (Guo et al., 2007)	Showed DPPH free radical scavenging activity (Guo et al., 2007)
3,7-dihydroxy-2,4,8-trimethoxyphenanthrene		
	<i>Pholidota yunnanensis</i> (Guo et al., 2007)	Showed DPPH free radical scavenging activity (Guo et al., 2007)
Coelonin		

Table 5. Contd

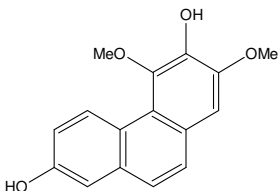
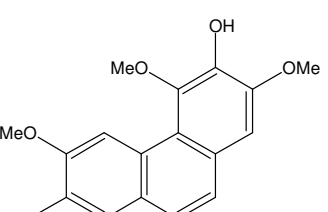
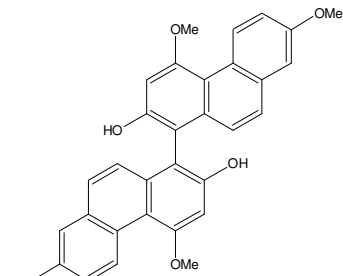
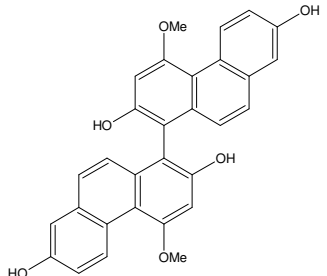
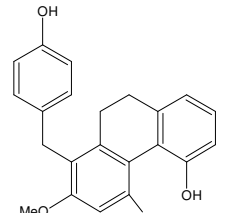
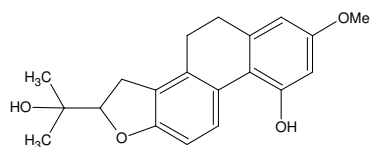
 <p>3,7-Dihydroxy-2,4-dimethoxyphenanthrene</p>	<p><i>Pholidota yunnanensis</i> (Guo et al., 2007)</p>	<p>Showed DPPH free radical scavenging activity (Guo et al., 2007)</p>
 <p>3,7-Dihydroxy-2,4,6-trimethoxyphenanthrene</p>	<p><i>Bulbophyllum Odoratissimum</i> (Chen et al., 2007)</p>	<p>Showed cytotoxicity activity (Chen et al., 2007)</p>
 <p>2,7,2',7',2''-Pentahydroxy-4,4',4'',7''-tetramethoxy-1,8,1',1''-triphenanthrene</p>	<p><i>Cremastra appendiculata</i> (Xue et al., 2006)</p>	<p>Showed cytotoxicity (Xue et al., 2006)</p>
 <p>Cirrhopetalanthin</p>	<p><i>Cremastra appendiculata</i> (Xue et al., 2006)</p>	<p>Showed cytotoxicity (Xue et al., 2006)</p>
 <p>Gymconopin A</p>	<p><i>Gymnadenia conopsea</i> (Matsuda et al., 2004)</p>	<p>Inhibit the antigen-induced degranulation (Matsuda et al., 2004)</p>



Table 5. Contd

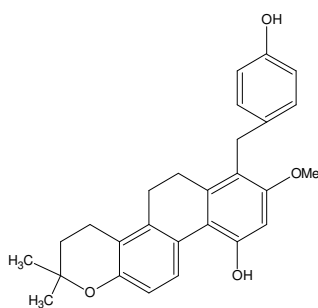
	<i>Gymnadenia conopsea</i> (Matsuda et al., 2004)	Inhibit the antigen-induced degranulation (Matsuda et al., 2004)
<b>Gymconopin B</b>		
	<i>Gymnadenia conopsea</i> (Matsuda et al., 2004)	Inhibit the antigen-induced degranulation (Matsuda et al., 2004)
<b>Gymconopin D</b>		
	<i>Gymnadenia conopsea</i> (Matsuda et al., 2004)	Inhibit the antigen-induced degranulation (Matsuda et al., 2004)
<b>Dihydroxy-2,6-bis(4-hydroxybenzyl)-5-methoxybenzyl</b>		
	<i>Spiranthes sinensis</i> var <i>amoena</i> (Tezuka et al., 1990)	
<b>Spiranthosol</b>		
	<i>Spiranthes sinensis</i> var <i>amoena</i> (Tezuka et al., 1990)	
<b>Spiranthoquinone</b>		

Table 5. Contd



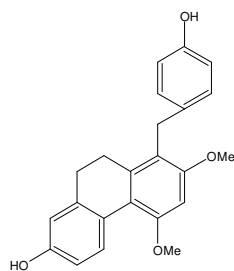
Spiranthol C

*Spiranthes sinensis* var  
amoena (Tezuka et al., 1990)



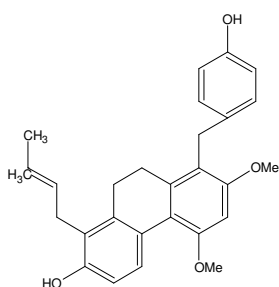
Spirasineol B

*Spiranthes sinensis* var  
amoena (Tezuka et al., 1990)



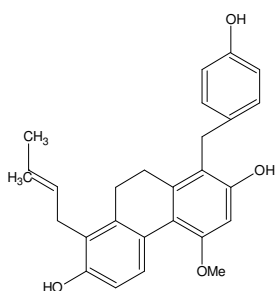
Sinensol A

*Spiranthes sinensis* var  
amoena (Lin et al., 2000)



Sinensol B

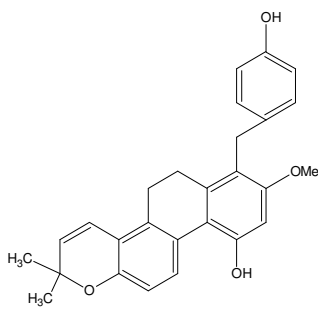
*Spiranthes sinensis* var  
amoena (Lin et al., 2000)



Sinensol C

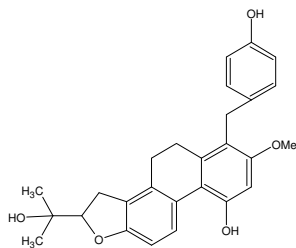
*Spiranthes sinensis* var  
amoena (Lin et al., 2000)

Table 5. Contd



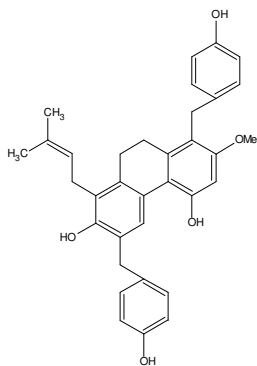
Sinensol D

*Spiranthes sinensis* var  
amoena (Lin et al., 2000)



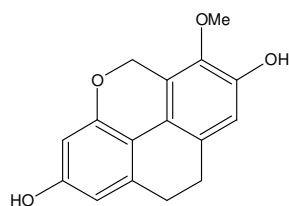
Sinensol E

*Spiranthes sinensis* var  
amoena (Lin et al., 2000)



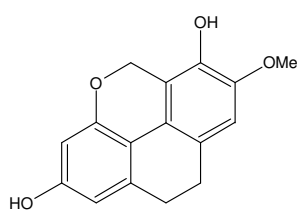
Sinensol F

*Spiranthes sinensis* var  
amoena (Lin et al., 2000)



Imbricatin

*Agrostophyllum brevipes*  
(Majumder et al., 2003)



Flaccidin

*Agrostophyllum brevipes*  
(Majumder et al., 2003)

Table 5. Contd

	<i>Agrostophyllum brevipes</i> and <i>Coelogyne flaccida</i> (Majumder et al., 1995)
Callosinin	
	<i>Agrostophyllum brevipes</i> (Majumder et al., 2003)
Agrostophyllin	
	<i>Agrostophyllum callosum</i> (Majumder et al., 2003)
Callosumin	

Table 6. Terpenoids isolated from Orchids.

	<i>Dendrobium nobile</i> (Zhao et al., 2001)	Stimulate the proliferation of murine T and B lymphocytes <i>in vitro</i> (Zhao et al., 2001)
Dendronobiloside A		
	<i>Dendrobium nobile</i> (Zhao et al., 2001)	Stimulate the proliferation of murine T and B lymphocytes <i>in vitro</i> (Zhao et al., 2001).
Dendroside A		

Table 6. Contd

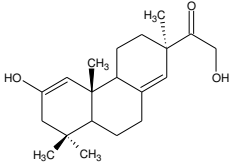
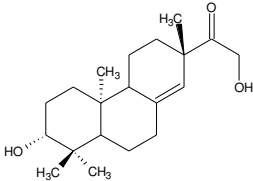
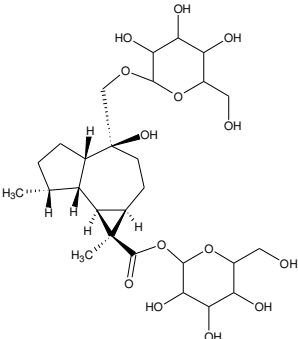
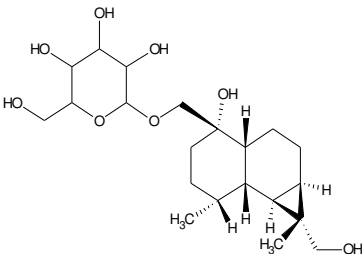
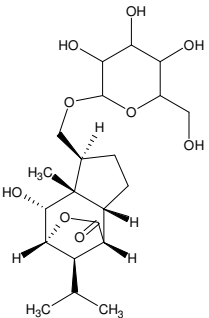
	Stems of <i>Ephemerantha lonchophylla</i> (Na et al., 1998)	Is capable of sensitizing cells that expressed the multidrug resistance phenotype to the toxicity of the anticancer drug doxorubicin (Na et al., 1998)
Lonchophylloid A		
	Stems of <i>Ephemerantha lonchophylla</i> (Na et al., 1998)	Is capable of sensitizing cells that expressed the multidrug resistance phenotype to the toxicity of the anticancer drug doxorubicin (Na et al., 1998)
Lonchophylloid B		
	<i>Dendrobium nobile</i> (Ye et al., 2002)	Showed immunomodulatory activity (Ye et al., 2002)
Dendroside D		
	<i>Dendrobium nobile</i> (Ye et al., 2002)	Showed immunomodulatory activity (Ye et al., 2002)
Dendroside E		
	<i>Dendrobium nobile</i> (Ye et al., 2002)	Showed immunomodulatory activity (Ye et al., 2002)
Dendroside F		

Table 6. Contd

	<i>Dendrobium nobile</i> (Ye et al., 2002)	Showed immunomodulatory activity (Ye et al., 2002)
Dendroside G	<i>Dendrobium moniliforme</i> (Zhao et al., 2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
	<i>Dendrobium moniliforme</i> Zhao et al. (2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
Dendromonilide A	<i>Dendrobium moniliforme</i> Zhao et al. (2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
	<i>Dendrobium moniliforme</i> Zhao et al. (2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
Dendromonilide B	<i>Dendrobium moniliforme</i> Zhao et al. (2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
	<i>Dendrobium moniliforme</i> Zhao et al. (2003)	Stimulate the proliferation of B cells and inhibit the proliferation of T cells <i>in vitro</i> (Zhao et al., 2003)
Dendromonilide C		

**Table 7.** Miscellaneous isolated from Orchids.

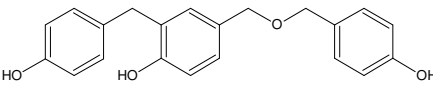
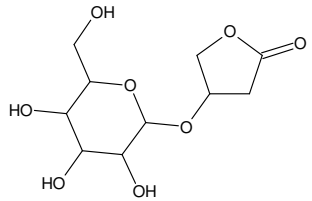
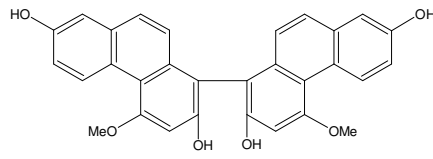
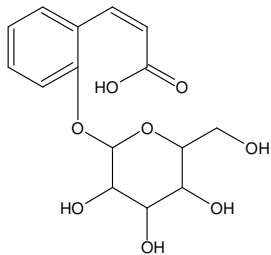
Structure	Source	Activities
Heptacosane (C <sub>27</sub> H <sub>56</sub> )	<i>Vanda roxburghii</i> Suresh et al. (2000)	Showed marked anti-inflammatory activity in carrageenan induced oedema in rats and mice as compared to phenylbutazone and was equipotent in adrenalectomised rats Chawla et al. (1992)
Octacosanol (C <sub>28</sub> H <sub>58</sub> O)	<i>Vanda roxburghii</i> Suresh et al. (2000)	Showed marked anti-inflammatory activity in carrageenan induced oedema in rats and mice as compared to phenylbutazone and was equipotent in adrenalectomised rats Chawla et al. (1992).
2,6-Dimethoxy-1,4-benzoquinone	<i>Cymbidium</i> sp. Hausen et al. (1984).	Can cause allergies Hausen et al. (1984)
Alkyl ferulates	Methanolic extract of <i>Dendrobium moniliforme</i> Lo et al. (2004).	Showed antioxidant activity Lo et al. (2004)
	MeOH extract of the rhizomes of <i>Gastrodia elata</i> Hayashi et al. (2002)	Showed relaxant effects on smooth muscle preparations isolated from guinea-pig ileum Hayashi et al. (2002)
<b>Gastrol</b> 	<i>Anoectochilus formosanus</i> Wu et al. (2007)	Shows significant antihepatotoxic activity Wu et al. (2007)
<b>Kinsenoside</b> 	<i>Cremastra appendiculata</i> Xia et al. (2005)	Showed cytotoxicity against human colon cancer (HCT-8), human hepatoma (Bel7402), human stomach cancer (BGC-823), human lung adenocarcinoma (A549), human breast cancer (MCF-7), and human ovarian cancer (A2780) cell lines Xia et al. (2005)
<b>Cirrhopetalanthrin</b> 	<i>Dendrobium aurantiacum</i> Yang et al. (2007)	Exhibited potent antioxidant activities Yang et al., (2007)
<b>cis-Melilotoside</b>		

Table 7. Contd

	<i>Dendrobium aurantiacum</i> Yang et al. (2007)	Exhibited potent antioxidant activities Yang et al. (2007)
Dihydromelilotoside	<i>Dendrobium aurantiacum</i> Yang et al. (2007)	Exhibited potent antioxidant activities Yang et al. (2007)
	<i>Gastrodia elata</i> Huang et al. (2007)	Exhibited in preventing PC12 cell apoptosis induced by serum deprivation through suppression of the JNK pathway Huang et al., (2007)
<i>trans</i> -Melilotoside	<i>Dendrobium densiflorum</i> Fan et al. (2001)	Exhibit anti-platelet aggregation activity <i>in vitro</i> Fan et al., (2001)
	<i>Dendrobium densiflorum</i> Fan et al. (2001)	Exhibit anti-platelet aggregation activity <i>in vitro</i> Fan et al. (2001)
bis(4-hydroxybenzyl)sulfide	<i>Dendrobium nobile</i> Zhang et al. (2007)	Displayed higher antioxidant activity than vitamin C. Also showed inhibitory effects on NO production without cytotoxicity Zhang et al. (2007)
	Scoparone	
	Scopoletin	
	Nobilone	



Table 7. Contd

	<p><i>Habenaria repens</i> (Johnson et al. (1999)</p>	<p>Inhibiting lipid peroxidation of human low density lipoprotein (LDL) Johnson et al., (1999)</p>
<p>Habenariol</p>	<p><i>Cymbidium goeringii</i> (Watanabe et al., 2007).</p>	<p>Showed hypotensive and diuretic activities (Watanabe et al., 2007).</p>
	<p><i>Bulbophyllum kwangtungense</i> Wu et al. (2006)</p>	<p>Exhibited anti-tumor activities against Hela (IC<sub>50</sub> = 140.9 μM) and K562 human tumor cell lines ((IC<sub>50</sub> = 138.8 μM) Wu et al., (2006)</p>
<p>Cymbidine A</p>	<p><i>Bulbophyllum kwangtungense</i> Wu et al. (2006)</p>	<p>Exhibited anti-tumor activities against Hela (IC<sub>50</sub> = 78.3 μM) and K562 human tumor cell lines ((IC<sub>50</sub> = 88.5 μM) Wu et al., (2006)</p>
	<p><i>Bulbophyllum kwangtungense</i> Wu et al. (2006)</p>	<p>Exhibited anti-tumor activities against Hela (IC<sub>50</sub> = 61.2 μM) and K562 human tumor cell lines ((IC<sub>50</sub> = 64.7 μM) (Wu et al., (2006)</p>
<p>7,8-dihydro-5-hydroxy-12,13-methylenedioxy-11-methoxyldibenz[b,f]oxepin</p>	<p>7,8-dihydro-4-hydroxy-12,13-methylenedioxy-11-methoxyldibenz[b,f]oxepin</p>	<p>7,8-dihydro-3-hydroxy-12, 13-methylenedioxy-11-methoxyldibenz[b,f]oxepin</p>

Table 7. Contd

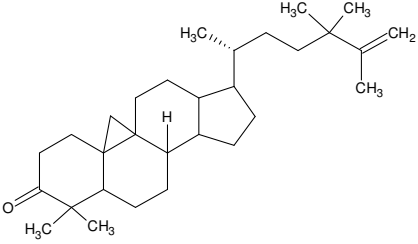
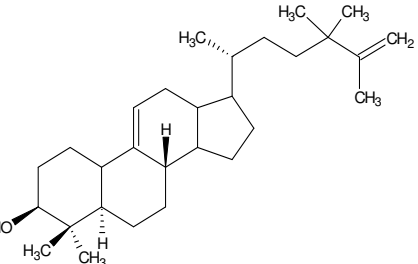
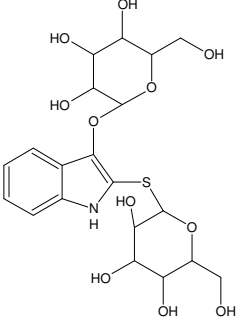
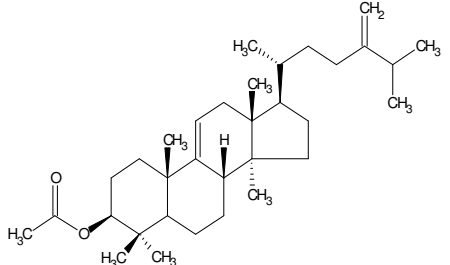
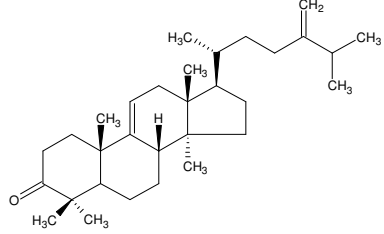
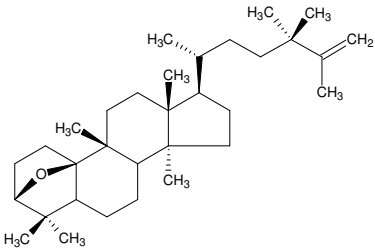
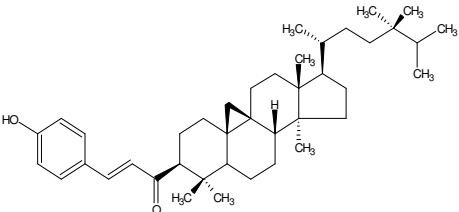
	<i>Scaphyglottis livida</i> (Déciga-Campos et al., 2007a)	Produced dose-dependent antinociceptive and anti-inflammatory effects (Déciga-Campos et al., 2007a)	
Cyclobalanone		<i>Scaphyglottis livida</i> (Déciga-Campos et al., 2007a)	Produced dose-dependent antinociceptive and anti-inflammatory effects (Déciga-Campos et al., 2007a)
5 $\alpha$ -lanosta-24,24-dimethyl-9(11),25-dien-3 $\beta$ -ol		<i>Calanthe discolor</i> and <i>C. liukiensis</i> Yoshikawa et al. (1998)	Showed an activating effect on skin blood flow Yoshikawa et al., (1998)
Calanthoside		<i>Agrostophyllum brevipes</i> Majumder et al. (2003)	
Agrostophyllinol		<i>Agrostophyllum brevipes</i> Majumder et al. (2003)	
Agrostophyllinone			

Table 7. Contd

	<i>Scaphyglottis livida</i> and <i>Nidema boothii</i> Estrada et al. (2002)
Nidemin	
	<i>Scaphyglottis livida</i> and <i>Nidema boothii</i> Estrada et al. (2002)
9,19-Cyclolanosta-24,24-dimethyl-25-en- 3β-yl-trans-p-hydroxycinnamate	

preparation of Yin tonic in the Chinese medicine needs to be revised in the light of modern science of health and diseases. Recent findings of phenanthrenes in cancer management and inflammations need also to be studied more extensively.

Clinical trials with orchids materials, though, particularly with regard to vascular embolizing agent are still sorely lacking. Relationship of this activity to health and disease has not been established, so direct extrapolation of such findings to medical recommendations is premature. However, they do suggest further study, including clinical trials of properly designed pharmaceutical products. Toward such an end, it is hoped that the present review will provide some valuable clues for ongoing explorations of this most fascinating botanical species. It is likely that much more will follow, as the medical community and public continue to take renewed interest in the Orchids as a therapeutic plant.

## REFERENCES

- Ahn EK, Jeon HJ, Lim EJ, Jung HJ, Park EH (2007). Anti-inflammatory and anti-angiogenic activities of *Gastrodia elata* Blume. *J. Hnopharmacol.* 110: 476-482.
- An SM, Park CH, Heo JC, Park JY, Woo SU, Seo JH, Lee MS, Cho KJ, Cho HS, Shin HM, Lee SH (2007). *Gastrodia elata* Blume protects against stress-induced gastric mucosal lesions in mice. *Int. J. Mole. Med.* 20: 209-215.
- Bae EY, Oh H, Oh WK, Kim MS, Kim BS, Kim BY, Sohn CB, Osada H, Ahn JS (2004). A new VHR dual-specificity protein tyrosine phosphatase inhibitor from *Dendrobium moniliiforme*. *Planta Medica* 70: 869-870.
- Baek NI, Choi SY, Park JK, Cho SW, Ahn EM, Jeon SG, Lee BR, Bahn JH, Kim YK, Shon IH (1999). Isolation and identification of succinic semialdehyde dehydrogenase inhibitory compound from the rhizome of *Gastrodia elata* Blume. *Arch. Pharmacol. Res.* 22: 219-224.
- Balzarini J, Schols D, Neyts J, Van Damme E, Peumans W, De Clercq E (1991). Alpha-(1-3)- and alpha-(1-6)-D-mannose-specific plant lectins are markedly inhibitory to human immunodeficiency virus and cytomegalovirus infections *in vitro*. *Antimicrob. Agents Chemother.* 35: 410-416.
- Balzarini J, Neyts J, Schols D, Hosoya M, Van Damme E, Peumans W, De Clercq E (1992). The mannose-specific plant lectins from *Cymbidium hybrid* and *Epipactis helleborine* and the (N-acetylglucosamine)n-specific plant lectin from *Urtica dioica* are potent and selective inhibitors of human immunodeficiency virus and cytomegalovirus replication *in vitro*. *Antiviral Res.* 18: 191-207.
- Basu KD, Gupta B, Bhattacharya SK, Lal R, Das PK (1971). Anti-inflammatory principles of *Vanda roxburghii*. *Curr. Sci.* 40-86.
- Berliocchi L (2004). In: Griffiths M, ed. *The Orchid in Lore and Legend*. Portland OR, Timber Press pp. 128-132.
- Bhaskar MU, Rao JM, Prakasa NS, Rao M (1991). Ochrone A, a novel 9, 10-dihydro-1,4-phenanthraquinone from *Coelogyne ochracea*. *J. Nat. Prod.* 54: 386-389.
- Bi ZM, Wang ZT, Xu LS, Xu GJ (2003). Studies on the chemical constituents of *Dendrobium fimbriatum*. *Yao Xue Xue Bao* 38: 526-529.
- Braem GJ, Charles OB, Margaret LB (1998). *The Genus Paphiopedilum: Natural History and Cultivation*, Vol. 1. Kissimmee, Florida: Botanical Publishers, Inc.
- Chang S (1977). *New Medical College Dictionary of Chinese Crude Drugs*: Shanghai Scientific Technologic Publisher: Shanghai.
- Chang S (1996). *New Medical College, "Dictionary of Chinese Crude Drugs," Vol. I*, Shanghai Scientific Technologic Publisher, Shanghai p. 667.
- Chapman H, Hall-CRC (2005). *Dictionary of natural products (DNP)* Boca Raton, USA. CD-ROM, version 13:1.
- Chawla AS, Sharma AK, Handa SS, Dhar KL (1992). Chemical studies

- and anti inflammatory activity of *Vanda roxburghii* roots. Indian J. Pharm. Sci. 54: 159-161.
- Chen KK, Chen AL (1935). The alkaloid of Chin-Shih-Hu. J. Biol. Chem. pp. 653-658.
- Chen CC, Wu LG, Ko FN, Teng CM (1994). Antiplatelet aggregation principles of *Dendrobium loddigesii*. J. Nat. Prod. 57: 1271-1274.
- Chen S, Li Y, Wu Y, Zhou Z, Sun L (1995). Effect of *Dendrobium nobile* Lindl. on gastric acid secretion, serum gastrin and plasma somatostatin concentration. Zhongguo Zhong Yao Za Zhi 20: 181-121.
- Chen HY, Shiao MS, Huang YL, Shen CC, Lin YL, Kuo YH, Chen CC (1999). Antioxidant principles from *Ephemerantha lonchophylla*. J. Nat. Prod. 62: 1225-1227.
- Chen CC, Huang YL, Teng CM (2000). Antiplatelet aggregation principles from *Ephemerantha lonchophylla*. Planta Medica 66: 372-374.
- Chen CM, Wang LF, Cheng KT, Hsu HH, Gau B, Su B (2004). Effects of *Anoectochilus formosanus* Hayata extract and glucocorticoid on lung maturation in preterm rats. Phytomedicine 11: 509-515.
- Chen Y, Xu J, Yut H, Qin CW, Zhang Y, Liu Y, Wang J (2007). *Bulbophyllum Odoratissimum* 3,7-Dihydroxy-2,4,6-trimethoxyphenanthrene. J. Korean Chem. Soc. 51: 352-355.
- Choi JH, Lee DU (2006). A new citryl glycoside from *Gastrodia elata* and its inhibitory activity on GABA transaminase. Chem. Pharm. Bull. 54: 1720-1721.
- Chopra RN, Nayar SL, Chopra IC (1956). Glossary of Indian medicinal plants. New Delhi. C.S.I.R pp. 216-219.
- Deciga-Campos M, González-Trujano E, Navarrete A, Mata R (2005). Antinociceptive effect of selected Mexican traditional medicinal species. Proceedings of the Western Pharmacol. Soc. 48: 70-72.
- Déciga-Campos M, Palacios-Espinosa JF, Reyes-Ramírez A, Mata R (2007<sup>a</sup>). Antinociceptive and anti-inflammatory effects of compounds isolated from *Scaphyglottis livida* and *Maxillaria densa*. J. Ethnopharmacol. In press.
- Déciga-Campos M, Rivero-Cruz I, Arriaga-Alba M, Castañeda-Corral G, Angeles-López GE, Navarrete A, Mata R (2007<sup>b</sup>). Acute toxicity and mutagenic activity of Mexican plants used in traditional medicine. J. Ethnopharmacol. 110: 334-342.
- Delaquis P, Stanich K, Toivonen P (2005). Effect of pH on the inhibition of *Listeria* spp. by vanillin and vanillic acid. J. Food Protection 68: 1472-1476.
- Dioscorides Pedanius (1543). De Materia Medica Frankfurt edition 1543 or De Materia Medica libra quinque 572 (In Imperial Library at Vienna).
- Ding CS, Shen YS, Li G, Wei Z, Wei F (2007). Study of a glycoprotein from *Gastrodia elata*: its effects of anticoagulation and antithrombosis. Zhongguo Zhong Yao Za Zhi 32: 1060-1064.
- Dreeler R (1981). The Orchids: Natural history and classification. Harvard University Press. Cambridge, MA.
- Dressler RL (1960). Classification and phylogeny in the orchidaceae. Ann. Miss. Bot. Gard. 47.
- Du D, Feng G, Liang H (1998). Embolotherapy of craniofacial tumors and vascular diseases: assessing the effect of different embolic agents. Lin Chuang Er Bi Yan Hou Ke Za Zhi 12: 266-268.
- Du XM, Sun NY, Chen Y, Irino N, Shoyama Y (2000). Hepatoprotective aliphatic glycosides from three *Goodyera* species. Biol. Pharm. Bull. 23: 731-773.
- Du X, Sun N, Tamura T, Mohri A, Sugiura M, Yoshizawa T, Irino N, Hayashi J, Shoyama Y (2001). Higher yielding isolation of kinsenoside in *Anoectochilus* and its antihyperliposis effect. Biol. Pharm. Bull. 24: 65-69.
- Du XM, Sun NY, Takizawa N, Guo YT, Shoyama Y (2002). Sedative and anticonvulsant activities of goodyerin, a flavonol glycoside from *Goodyera schlechtendaliana*. Phytotherapy Res. 16: 261-26.
- Du XM, Sun NY, Hayashi J, Chen Y, Sugiura M, Shoyama Y (2003). Hepatoprotective and antihyperliposis activities of *in vitro* cultured *Anoectochilus formosanus*. Phytotherapy Res. 17: 30-33.
- Estrada S, Rojas A, Mathison Y, Israel A, Mata R (1999). Nitric oxide/cGMP mediates the spasmolytic action of 3,4'-dihydroxy-5,5'-dimethoxybibenzyl from *Scaphyglottis livida*. Planta Medica 65: 109-114.
- Estrada S, Toscano RA, Mata R (1999a). New phenanthrene derivatives from *maxillaria densa*. J. Nat. Prod. 62: 1175-1178.
- Estrada S, López-Guerrero JJ, Villalobos-Molina R, Mata R (2004). Spasmolytic stilbenoids from *Maxillaria densa*. Fitoterapia 75: 690-695.
- Estrada S, Acevedo L, Rodríguez M, Toscazo RA, Mata R (2002). New triterpenoids from orchids *Scaphyglottis livida* and *Nidema boothii*. Nat. Prod. Lett. 16: 81-86.
- Fan ZN, Xiao HS, Fan XH, Wu WS (1997). Study on tissue culture of *Anoectochilus roxburghii*. Journal Fujian Normal University (Nat Sci Ed) 13: 82-87.
- Fan C, Wang W, Wang Y, Qin G, Zhao W (2001). Chemical constituents from *Dendrobium densiflorum*. Phytochemistry 57: 1255-1258.
- Feng XS, Qiu FZ, Xu Z (1995). Experimental studies of embolization of different hepatotropic blood vessels using *Bletilla striata* in dogs. J. Tianjin University Trad. Chin. Med. 15: 45-49.
- Feng G, Kramann B, Zheng C, Zhou R (1996). Comparative study on the long-term effect of permanent embolization of hepatic artery with *Bletilla striata* in patients with primary liver cancer. J. Tianjin University Trad. Chin. Med. 16: 111-116.
- Feng GS, Li X, Zheng CS, Zhou CK, Liu X, Wu HP (2003). Mechanism of inhibition of tumor angiogenesis by *Bletilla* colloid: an experimental study. Zhonghua Yi Xue Za Zhi. 83: 412-416.
- Ferreira J, Floriani AE, Filho VC, Delle MF, Yunes RA, Calixto JB, Santos AR (2000). Antinociceptive properties of the methanolic extract and two triterpenes isolated from *Epidendrum Mosenii* stems (Orchidaceae). Life Sci. 66: 791-802.
- Fitzgerald DJ, Stratford M, Gasson MJ, Ueckert J, Bos A, Narbad A (2004). Mode of antimicrobial action of vanillin against *Escherichia coli*, *Lactobacillus plantarum* and *Listeria innocua*. J. Appl. Microbiol. 97: 104-113.
- Fladby T, Bryhn G, Halvorsen O, Rose I, Wahlund M, Wiig P, Wetterberg L (2004). Olfactory response in the temporal cortex of the elderly measured with near infrared spectroscopy: a preliminary feasibility study. J. Cerebral Blood Flow Metabolism 24: 677-680.
- Floriani AE, Ferreira J, Santos AR, Delle-Monache F, Yunes RA, Cechinel-Filho V (1998). Analgesic compounds from *Epidendrum mosenii* stems. Pharmazie. 53: 426-427.
- Gamez EJ, Luyengi L, Lee SK, Zhu LF, Zhou BN, Fong HH (1998). Antioxidant flavonoid glycosides from *Daphniphyllum calycinum*. J. Nat. Prod. 61: 706-708.
- Gong YH (1986). <sup>13</sup>C Chemical Shift of Natural Organic Compounds, Tomus 1. Yunnan Science and Technology Press, Kunming pp. 356-359.
- Gong YQ, Fan Y, Wu DZ, Yang H, Hu ZB, Wang ZT (2004). *In vivo* and *in vitro* evaluation of erianin, a novel anti-angiogenic agent. Eur. J. Cancer 40: 1554-1565.
- Guo XY, Wang J, Wang NL, Kitanaka S, Yao XS (2007). 9, 10-Dihydrophenanthrene derivatives from *Pholidota yunnanensis* and scavenging activity on DPPH free radical. J. Asian Natural Prod. Res. 9: 165-174.
- Ha JH, Lee DU, Lee JT, Kim JS, Yong CS, Kim JA, Ha JS, Huh K (2000). 4-Hydroxybenzaldehyde from *Gastrodia elata*, is active in the antioxidation and GABAergic neuromodulation of the rat brain. J. Ethnopharmacol. 73: 329-333.
- Ha JH, Shin SM, Lee SK, Kim JS, Shin US, Huh K, Kim JA, Yong CS, Lee NJ, Lee DU (2001). *In vitro* effects of hydroxybenzaldehydes from *Gastrodia elata* and their analogues on GABAergic neurotransmission, and a structure-activity correlation. Planta Medica 67: 877-880.
- Hayashi J, Sekine T, Deguchi S, Lin Q, Horie S, Tsuchiya S, Yano S, Watanabe K, Ikegami F (2002). Phenolic compounds from *Gastrodia* rhizome and relaxant effects of related compounds on isolated smooth muscle preparation. Phytochemistry 59: 513-519.
- He AM, Wang MS, Yang J (1997). Flavonoids from *Anoectochilus roxburghii*. Chin. Trad. Herb Drugs 28: 517-522.
- He C, Wang C, Guo S, Yang J, Xiao P (2006). A Novel Flavonoid Glucoside from *Anoectochilus roxburghii* (Wall.) Lindl. J. Integrative Plant Biol. 48: 359-363.
- Heo JC, Woo SU, Son M, Park JY, Choi WS, Chang KT, Kim SU, Yoon EK, Kim YH, Shin HM, Lee SH (2007). Anti-tumor activity of *Gastrodia elata* Blume is closely associated with a GTP-Ras-

- dependent pathway. *Oncol. Reports* 8: 849-853.
- Hernández-Romero Y, Rojas JI, Castillo R, Rojas A, Mata R (2004). Spasmolytic effects, mode of action, and structure-activity relationships of stilbenoids from *Nidema boothii*. *J. Nat. Prod.* 67: 160-167.
- Hernández-Romero Y, Acevedo L, Sánchez ML, Shier WT, Abbas HK, Mata R (2005). Phytotoxic activity of bibenzyl derivatives from the orchid *Epidendrum rigidum*. *J. Agric. Food Chem.* 53: 6276-6280.
- Ho CK, Chen CC (2003). Moscatilin from the orchid *Dendrobium loddigesii* is a potential anticancer agent. *Cancer Investigation* 21: 729-736.
- Hsieh MT, Wu CR, Chen CF (1997). Gastrodin and p-hydroxybenzyl alcohol facilitate memory consolidation and retrieval, but not acquisition, on the passive avoidance task in rats. *J. Ethnopharmacol.* 56: 45-54.
- Hsieh CL, Tang NY, Chiang SY, Hsieh CT, Lin JG (1999). Anticonvulsive and free radical scavenging actions of two herbs, *Uncaria rhynchophylla* (MIQ) Jack and *Gastrodia elata* Bl., in kainic acid-treated rats. *Life Sci.* 65: 2071-2082.
- Hsieh CL, Chang CH, Chiang SY, Li TC, Tang NY, Pon CZ, Hsieh CT, Lin JG (2000). Anticonvulsive and free radical scavenging activities of vanillyl alcohol in ferric chloride-induced epileptic seizures in Sprague-Dawley rats. *Life Sci.* 67: 1185-1195.
- Huang NK, Lin YL, Cheng JJ, Lai WL (2004). *Gastrodia elata* prevents rat pheochromocytoma cells from serum-deprived apoptosis: the role of the MAPK family. *Life Sci.* 75:1649-1657.
- Huang Y, Guh J, Teng C (2005). Denbinobin-mediated anticancer effect in human K562 leukemia cells: role in tubulin polymerization and Bcr-Abl activity. *J. Biomed. Sci.* 12: 113-121.
- Huang ZB, Wu Z, Chen FK, Zou LB (2006). The protective effects of phenolic constituents from *Gastrodia elata* on the cytotoxicity induced by KCl and glutamate. *Archives Pharmacol Res.* 29: 963-968.
- Huang NK, Chern Y, Fang JM, Lin CI, Chen WP, Lin YL (2007). Neuroprotective principles from *Gastrodia elata*. *J. Nat. Prod.* 70: 571-574.
- Hausen BM, Shoji A, Jarchow O (1984). Orchid allergy. *Archives Dermatol.* 120: 1206-1208.
- Ikeda Y, Nonaka H, Furumai T, Igarashi Y (2005). Cremastrine, a pyrrolizidine alkaloid from *Cremastra appendiculata*. *J. Nat. Prod.* 68: 572-573.
- Ikeuchi M, Yamaguchi K, Nishimura T, Yazawa K (2005). Effects of *Anoectochilus formosanus* on endurance capacity in mice. *J. Nutri. Sci. Vitaminol.* 51: 40-44.
- Ja CB, Won KC (2002). Studies on the constituents of *Impatiens nolitangere* L. *Saengyak Hakhochei* 4: 263-266.
- Johnson MK, Alexander KE, Lindquist N, Loo G (1999). A phenolic antioxidant from the freshwater orchid, *Habenaria repens*. *Comparative Biochemistry Physiology part C: Pharmacol. Toxicol. Endocrinol.* 122: 211-214.
- Jung TY, Suh SI, Lee H, Kim IS, Kim HJ, Yoo HS, Lee SR (2007). Protective effects of several components of *Gastrodia elata* on lipid peroxidation in gerbil brain homogenates. *Phytotherapy Research* in print.
- Khan MR, Omoloso AD (2004). Antibacterial activity of *Galeola foliata*. *Fitoterapia.* 75: 494-486.
- Kim HJ, Moon KD, Oh SY, Kim SP, Lee SR (2001). Ether fraction of methanol extracts of *Gastrodia elata*, a traditional medicinal herb, protects against kainic acid-induced neuronal damage in the mouse hippocampus. *Neurosci. Lett.* 314: 65-68.
- Kim HJ, Moon KD, Lee DS, Lee SH (2003). Ethyl ether fraction of *Gastrodia elata* Blume protects amyloid beta peptide-induced cell death. *J. Thnopharmacol.* 84: 95-98.
- Kim HJ, Lee SR, Moon KD (2003a). Ether fraction of methanol extracts of *Gastrodia elata*, medicinal herb protects against neuronal cell damage after transient global ischemia in gerbils. *Phytotherapy Res.* 17: 909-912.
- Kong JM, Goh NK, Chia LS, Chia TF (2003). Recent advances in traditional plant drugs and Orchids. *Acta Pharmacologica Sinica* 24: 7-21.
- Kudo Y, Tanaka A, Yamada K (1983). Dendrobine, an antagonist of beta-alanine, taurine and of presynaptic inhibition in the frog spinal cord. *Brit. J. Pharmacol.* 78: 709-715.
- Langham W (1579). *The garden of health*. London. pp.123-126.
- Lans CA (2006). Ethnomedicines used in Trinidad and Tobago for urinary problems and diabetes mellitus. *J. Ethnobiol. Ethnomed.* 13: 45-52.
- Lans C, Harper T, Georges K, Bridgewater E (2001). Medicinal and ethnoveterinary remedies of hunters in Trinidad. *BMC complementary and alternative medicine* 1: 10-15.
- Lawler LJ (1984). *Ethnobotany of the Orchidaceae*. In: Arditti J, editor, *Orchid Biology: Review and Perspectives-3*. Ithaca, Cornell University Press. pp. 27-149.
- Lee YS, Ha JH, Yong CS, Lee DU, Huh K, Kang YS, Lee SH, Jung MW, Kim JA (1999). Inhibitory effects of constituents of *Gastrodia elata* Bl. on glutamate-induced apoptosis in IMR-32 human neuroblastoma cells. *Archives Pharm. Res.* 22: 404-409.
- Lee JY, Jang YW, Kang HS, Moon H, Sim SS, Kim CJ (2006). Anti-inflammatory action of phenolic compounds from *Gastrodia elata* root. *Archives Pharm. Res.* 29: 849-858.
- Li MF, Hirata Y, Xu GJ, Niwa M, Wu HM (1991). Studies on the chemical constituents of *Dendrobium loddigesii* rolfe. *Yao Xue Xue Bao.* 26: 307-310.
- Li YM, Wang HY, Liu GQ (2001). Erianin induces apoptosis in human leukemia HL-60 cells. *Acta Pharmacologica Sinica* 22: 1018-1022.
- Li HF, Yan Z, Zhou Z, Xu L, Daikonya A, Wang J (2006). Anti-allergic agents from natural sources. *Heterocycles* 68: 1259-1265.
- Lin JM, Lin CC, Chiu HF, Yang JJ, Lee SG (1993). Evaluation of the anti-inflammatory and liver-protective effects of *Anoectochilus formosanus*, *Ganoderma lucidum* and *Gynostemma pentaphyllum* in rats. *Am. J. Chin. Med.* 21, 59-69.
- Lin CC, Namba T (1985). Historical and herbological studies on the traditional Japanese and Chinese crude drugs. On the *shan-ci-gu Yakushigaku Zasshi.* 20: 88-98.
- Lin TH, Chang SJ, Chen CC, Wang JP, Tsao LT (2001). Two phenanthraquinones from *Dendrobium moniliforme*. *J. Nat. Prod.* 64: 1084-1086.
- Lin YL, Huang R, Don M, Kuo Y (2000). Dihydrophenanthrenes from *Spiranthes sinensis*. *J. Nat. Prod.* 63: 1608-1610.
- Lin YL, Chen WP, Macabalang AD (2005). Dihydrophenanthrenes from *Bletilla formosana*. *Chem. Pharm. Bull.* 53: 1111-1113.
- Liu QF, Zhao WM (2003). A new dedonbrine-type alkaloid from *Dendrobium nobile*. *Chin. Chemical Lett.* 14:278-279.
- Lo SF, Mulabagal V, Chen CL, Kuo CL, Tsay HS (2004). Bioguided fractionation and isolation of free radical scavenging components from in vitro propagated chinese medicinal plants *Dendrobium tosaense* Makino and *Dendrobium moniliforme* SW. *J. Agric. Food Chem.* 52: 6916-6919.
- Luer CA (1993). *Icones Pleurothallidinarium X. Systematics of Dracula*. Monographs in Systematic Botany from the Missouri Botanical Garden 46: 1-244.
- Luo H, Lin S, Ren F, Wu L, Chen L, Sun Y (2007). Antioxidant and antimicrobial capacity of Chinese medicinal herb extracts in raw sheep meat. *J. Food Protection* 70: 1440-1445.
- Majumder PL, Banerjee S, Maiti DC (1995). Stilbenoids from the orchids *Agrostophyllum callosum* and *Coelogyne flaccida*. *Phytochemistry* 39, 649-653.
- Majumder PL, Sen S, Majumder S (2001). Phenanthrene derivatives from the orchid *Coelogyne cristata*. *Phytochemistry* 58: 581-586.
- Majumder PL, Sen S, Majumder S (2003). Triterpenoids from orchids *Agrostophyllum brevipes* and *Agrostophyllum callosum*. *Phytochemistry* 62: 591-596.
- Markham KR, Ternai B, Stanley R, Geiger H, Mabry TJ (1978). Carbon-13 NMR studies of flavonoid glycosides: Naturally occurring flavonoid glycosides and their alylated derivatives. *Tetrahedron* 34: 1389-1397.
- Martin de la Cruz (1552), "Badiano Codex" by, Collection of Mexican Codices.
- Matsuda H, Morikawa T, Xie H, Yoshikawa M (2004). Antiallergic phenanthrenes and stilbenes from the tubers of *Gymnadenia conopsea*. *Planta Medica* 70: 847-855.
- Matu EN, van Staden J (2003). Antibacterial and anti-inflammatory activities of some plants used for medicinal purposes in Kenya. *J. Ethnopharmacol.* 87: 35-41.
- Menashian L, Flann M, Douglas-Paxton D, Raymond J (1992).

- Improved food intake and reduced nausea and vomiting in patients given a restricted diet while receiving cisplatin chemotherapy. *J. Am. Dietetic Assoc.* 92: 58–61.
- Merghem RM, Jay M, Viricel MR, Bayet C, Voirin B (1995). Five 8-C-benzylated flavonoids from *Thymus hirtus*. *Phytochemistry* 38: 637–640.
- Miyazawa M, Shimamura H, Nakamura S, Sugiura W, Kosaka H, Kameoka H (1999). Moscatilin from *Dendrobium nobile*, a naturally occurring bibenzyl compound with potential antimutagenic activity. *J. Agric. Food Chem.* 47: 2163-2167.
- Morikawa T, Xie H, Matsuda H, Wang T, Yoshikawa M (2006). Bioactive constituents from Chinese natural medicines. XVII. constituents with radical scavenging effect and new glucosyloxybenzyl 2-isobutylmalates from *Gymnadenia conopsea*. *Chem. Pharm. Bull.* 54: 506-513.
- Morita H, Koyama K, Sugimoto Y, Kobayashi J (2005). Antimitotic activity and reversal of breast cancer resistance protein-mediated drug resistance by stilbenoids from *Bletilla striata*. *Bioorg. Med. Chem. Lett.* 15: 1051-1054.
- Na GX, Wang TS, Yin L, Pan Y, Guo YL, LeBlanc GA, Reinecke MG, Watson WH, Krawiec M (1998). Two pimarane diterpenoids from *Ephemerantha lonchophylla* and their evaluation as modulators of the multidrug resistance phenotype. *J. Nat. Prod.* 61: 112-115.
- Nayak BS, Suresh R, Rao AV, Pillai GK, Davis EM, Ramkisson V, McRae A (2005). Evaluation of wound healing activity of *Vanda roxburghii* R.Br (Orchidaceae): a preclinical study in a rat model. *Int. J. Lower Extremity Wounds* 4: 200-204.
- Olof TC (1972). Survival and flowering of some perennial herbs II. The behavior of some orchids on permanent plots. *Oikos* 23: 23-28.
- Peng J, Xu Q, Xu Y, Qi Y, Han X, Xu L (2007). A new anticancer dihydroflavonoid from the root of *Spiranthes australis* (R. Brown) Lindl. *Nat. Prod. Res.* 21: 641-645.
- Prasad DN, Achari G (1966). A study of anti-arthritis action of *Vanda roxburghii* in albino rats. *J. Indian Med. Assoc.* 46: 234-237.
- Qiu H, Tang W, Tong X, Ding K, Zuo J (2007). Structure elucidation and sulfated derivatives preparation of two alpha-d-glucans from *Gastrodia elata* Bl. and their anti-dengue virus bioactivities. *Carbohydrate Res.* 342: 2230-2236.
- Reinikka MA (1995).. A history of the Orchid. Portland OR, Timber Press pp. 246-249.
- Rhee JK, Kim PG, Baek BK, Lee SB, Ahan BZ (1982). Isolation of anthelmintic substance on *Clonorchis Sinensis* from tuber of *Bletilla striata*. *Kisaengchungghak Chapchi.* 20: 142-146.
- Satish MN, Abhay PS, Chen-Yue L, Chao-Lin K, Hsin-Sheng T (2003). Studies on tissue culture of Chinese medicinal plant resources in Taiwan and their sustainable utilization. *Bot. Bull. Acad. Sin.* 44: 79-98.
- Shih CC, Wu YW, Lin WC (2001). Ameliorative effects of *Anoectochilus formosanus* extract on osteopenia in ovariectomized rats. *J. Ethnopharmacol.* 77: 233-238.
- Shih CC, Wu YW, Lin WC (2002). Antihyperglycaemic and anti-oxidant properties of *Anoectochilus formosanus* in diabetic rats. *Clin. Exp. Pharm. Physiol.* 29: 684-668.
- Shih CC, Wu YW, Lin WC (2003). Scavenging of reactive oxygen species and inhibition of the oxidation of low density lipoprotein by the aqueous extraction of *Anoectochilus formosanus*. *Am. J. Chin. Med.* 31: 25-36.
- Shih CC, Wu YW, Hsieh CC, Lin WC (2004). Effect of *Anoectochilus formosanus* on fibrosis and regeneration of the liver in rats. *Clin. Exp. Pharmacol. Physiol.* 31: 620-625.
- Shih CC, Wu YW, Lin WC (2005). Aqueous extract of *Anoectochilus formosanus* attenuate hepatic fibrosis induced by carbon tetrachloride in rats. *Phytomedicine* 12: 453-60.
- Shim JS, Kim JH, Lee J, Kim SN, Kwon HJ (2004). Anti-angiogenic activity of a homoisoflavanone from *Cremastra appendiculata*. *Planta Med.* 70: 171-173.
- Shimizu M, Shogawa H, Hayashi T, Arisawa M, Suzuki S, Yoshizaki M, Morita N, Ferro E, Basualdo I, Berganza LH (1988). Anti-inflammatory constituents of topically applied crude drugs. III. Constituents and anti-inflammatory effect of Paraguayan crude drug "Tamandá cuná" (*Catasetum barbatum* LINDLE). *Chem. Pharm. Bull.* 36: 4447-4452.
- Shimura H, Matsuura M, Takada N, Koda Y (2007). An antifungal compound involved in symbiotic germination of *Cypripedium macranthos* var. *rebunense* (Orchidaceae). *Phytochemistry* 68: 1442-1447.
- Shyur LF, Chen CH, Lo CP, Wang SY, Kang PL, Sun SJ, Chang CA, Tzeng CM, Yang NS (2004). Induction of apoptosis in MCF-7 human breast cancer cells by phytochemicals from *Anoectochilus formosanus*. *J. Biomed. Sci.* 11: 928-939.
- Sun J, Wang C, Zhang J (2005). Effect of polysaccharides from *Bletilla striata* on the adhesion of human umbilical venous endothelial cells. *Zhong Yao Cai.* 28: 1006-1008.
- Suresh PK, Subramoniam A, Pushpangadan P (2000). Aphodisiac activity of *Vanda tessellata*. *Indian J. Pharmacol.* 32: 300-304.
- Szlachetko D (2001). Genera et species *Orchidaliium*. 1. *Polish Bot. J.* 46: 11-26.
- Tezuka Y, Li J, Hirano H, Ueda M, Nagashima K, Kikuchi T (1990). Studies on the constituents of Orchidaceae plants IX. Constituents of *Spiranthes sinensis* (PERS.) AMES var. *amoena* (*M. Bieberson*) HARA. Structures of spiranthesol, spiranthoquinone, spiranthol C and spirasineol B, new isopentenylidihydrophenantrenes. *Chem. Pharm. Bull.* 38: 629-635.
- Torgils F, Dag O (2003). Anthocyanins from flowers of the orchids *Dracula chimaera* and *D. cordobae*. *Phytochemistry* 63: 783-787.
- Tseng CC, Shang HF, Wang LF, Su B, Hsu CC, Kao HY, Cheng KT (2006). Antitumor and immunostimulating effects of *Anoectochilus formosanus* Hayata. *Phytomedicine* 13: 366-370.
- Turner W (1568). The first and seconde partes of the Herbal of William Turner, doctor in Phisick, lately oversene, corrected and enlarged with the Third Parte. Cologne (original publication 1551).
- Van der Meer FJ, de Haan CA, Schuurman NM, Hajjema BJ, Peumans WJ, Van Damme EJ, Delputte PL, Balzarini J, Egberink HF (2007). Antiviral activity of carbohydrate-binding agents against Nidovirales in cell culture. *Antiviral Res.* 76: 21-29.
- Venkateswarlu S, Raju MS, Subbaraju GV (2002). Synthesis and biological activity of isoamoenylin, a metabolite of *Dendrobium amoenum*. *Biosci. Biotechnol. Biochem.* 66: 2236-2238.
- Victoire, C., Berrurier, M.H., Guth, A.L. 1988. Isolation of flavonol glycosides from *Ginkgo biloba* leaves. *Planta Med.* 54: 245–247.
- Villalobos-Molina R, Mata R (2006). Endothelium-independent relaxation of aorta rings by two stilbenoids from the orchids *Scaphyglottis livida*. *Fitoterapia* 77: 236-239.
- Wang X, Bauw G, Van Damme EJ, Peumans WJ, Chen ZL, Van Montagu M, Angenon G, Dillen W (2001). Gastrodinin-like mannose-binding proteins: a novel class of plant proteins with antifungal properties. *Plant J.* 25: 651-661.
- Wang SY, Kuo YH, Chang HN, Kang PL, Tsay HS, Lin KF, Yang NS, Shyur LF (2002). Profiling and characterization antioxidant activities in *Anoectochilus formosanus* hayata. *J. Agric. Food Chemistry* 50: 1859-1865.
- Wang LF, Lin CM, Shih CM, Chen HJ, Su B, Tseng CC, Gau BB, Cheng KT (2005). Prevention of cellular oxidative damage by an aqueous extract of *Anoectochilus formosanus*. *Annales. New York Academy of Sciences* 1042: 379-386.
- Wang J, Matsuzaki K, Kitanaka S (2006). Stilbene derivatives from *Pholidota chinensis* and their anti-inflammatory activity. *Chem. Pharm. Bulletin.* 54: 1216-1218.
- Wang C, Sun J, Luo Y, Xue W, Diao H, Dong L, Chen J, Zhang J (2006). A polysaccharide isolated from the medicinal herb *Bletilla striata* induces endothelial cells proliferation and vascular endothelial growth factor expression *in vitro*. *Biotechnol. Lett.* 28: 539-543.
- Wang J, Zeng JB, Zhao XF, Li Q, Wang SX (2007). Effects of *Gymnadenia conopsea* alcohol extract on collagen synthesis in rat lungs exposed to silica and its mechanism of antioxidative stress. *Zhong Xi Yi Jie He Xue Bao* 5: 50-55.
- Watanabe K, Tanaka R, Sakurai H, Iguchi K, Yamada Y, Hsu CS, Sakuma C, Kikuchi H, Shibayama H, Kawai T (2007). Structure of cymbidine A, a monomeric peptidoglycan-related compound with hypotensive and diuretic activities, isolated from a higher plant, *Cymbidium goeringii* (Orchidaceae). *Chemical Pharmaceutic Bulletin* 55: 780-783.
- Won JH, Kim JY, Yun KJ, Lee JH, Back NI, Chung HG, Chung SA, Jeong TS, Choi MS, Lee KT (2006). Gigantol isolated from the whole

- plants of *Cymbidium goeringii* inhibits the LPS-induced iNOS and COX-2 expression via NF-kappaB inactivation in RAW 264.7 macrophages cells. *Planta Med.* 72: 1181-1187.
- Wu HQ, Xie L, Jin XN, Ge Q, Jin H, Liu GQ (1989). The effect of vanillin on the fully amygdala-kindled seizures in the rat. *Yao Xue Xue Bao* 24: 482-486.
- Wu CR, Hsieh MT, Huang SC, Peng WH, Chang YS, Chen CF (1996). Effects of *Gastrodia elata* and its active constituents on scopolamine-induced amnesia in rats. *Planta Medica* 62: 317-321.
- Wu HS, Xu JH, Chen LZ, Sun JJ (2004). Studies on anti-hyperglycemic effect and its mechanism of *Dendrobium candidum*. *Zhongguo Zhong Yao Za Zhi* 29: 160-163.
- Wu, B, He, S., Pan, Y.J. 2006. New dihydrodibenzoxepins from *Bulbophyllum kwangtungense*. *Planta Medica* 72: 1244-1247.
- Wu P, Hsu Y, Jao C (2006). Indol alkaloids from *Cephalanceropsis gracilis*. *J. Nat. Prod.* 69: 1467-1470.
- Wu JB, Lin WL, Hsieh CC, Ho HY, Tsay HS, Lin WC (2007). The hepatoprotective activity of kinsenoside from *Anoectochilus formosanus*. *Phytotherapy Res.* 21: 58-61.
- Xia WB, Xue Z, Li S, Wang SJ, Yang YC, He DX, Ran GL, Kong LZ, Shi JG (2005). Chemical constituents from tuber of *Cremastra appendiculata*. *Zhongguo Zhong Yao Za Zhi.* 30: 1827-1830.
- Xue Z, Li S, Wang S, Wang Y, Yang Y, Shi J, He L (2006). Mono-, Bi-, and triphenanthrenes from the tubers of *Cremastra appendiculata*. *J. Nat. Prod.* 69: 907-913.
- Yang NS, Shyur LF, Chen CH, Wang SY, Tzeng CM (2004). Medicinal herb extract and a single-compound drug confer similar complex pharmacogenomic activities in mcf-7 cells. *J. Biomed. Sci.* 11: 418-422.
- Yang L, Qin LH, Bligh SW, Bashall A, Zhang CF, Zhang M, Wang ZT, Xu LS (2006a). A new phenanthrene with a spiro lactone from *Dendrobium chrysanthum* and its anti-inflammatory activities. *Bioorg. Med. Chem.* 14, 3496-3501.
- Yang L, Wang Z, Xu L (2006). Simultaneous determination of phenols (Bibenzyl, phenanthrene, and fluorene) in *Dendrobium* species by high-performance liquid chromatography with diode array detection. *J. Chromatograph A* 1104: 230-237.
- Yang L, Han H, Nakamura N, Hattori M, Wang Z, Xu L (2007). Bio-guided isolation of antioxidants from the stems of *Dendrobium aurantiacum* var. *denneanum*. *Phytotherapy Res.* 21: 696-698.
- Yi, YF, Xing FW, Huang XX, Chen HF (2005). Medicinal plants of *Bulbophyllum* species in China. *J. Trop. Subtropical Bot.* 13, 65-69.
- Ye Q, Qin G, Zhao W (2002). Immunomodulatory sesquiterpene glycosides from *Dendrobium nobile*. *Phytochemistry.* 61: 885-890.
- Yoshikawa M, Murakami T, Kishi A, Sakurama T, Matsuda H, Nomura M, Matsuda H, Kubo M (1998). Novel indole S,O-bisdesmoside, calanthoside, the precursor glycoside of tryptanthrin, indirubin, and isatin, with increasing skin blood flow promoting effects, from two *Calanthe* species (Orchidaceae). *Chem. Pharm. Bull.* 46: 886-888.
- You HL, Park JD, Baek NI, Kim S, Ahn BZ (1995). *In vitro* and *in vivo* antimutagenic phenanthrenes from the aerial parts of *Dendrobium nobile*. *Planta Medica* 61: 178-180.
- Yu SJ, Kim JR, Lee CK, Han JE, Lee JH, Kim HS, Hong JH, Kang SG (2005). *Gastrodia elata* blume and an active component, p-hydroxybenzyl alcohol reduces focal ischemic brain injury through antioxidant related gene expressions. *Biol. Pharm. Bull.* 28: 1016-1020.
- Zhang D, Zhang JJ (2005). Effect of *Coeloglossum viride* var. *bracteatum* extract on oxidation injury in sub-acute senescent model mice. *Zhongguo Yi Xue Ke Xue Yuan Xue Bao.* 27: 729-733.
- Zhang D, Zhang Y, Liu G, Zhang J (2006). Dactylorhin B reduces toxic effects of beta-amyloid fragment (25-35) on neuron cells and isolated rat brain mitochondria. *Naunyn Schmiedeberg's Archives Pharmacol.* 374: 117-125.
- Zhang D, Liu GT, Shi JG, Zhang JJ (2006a). Effects of *Coeloglossum viride* var. *bracteatum* extract on memory deficits and pathological changes in senescent mice. *Basic Clin. Pharmacol. Toxicol.* 98: 55-60.
- Zhang D, Liu G, Shi J, Zhang J (2006b). *Coeloglossum viride* var. *bracteatum* extract attenuates D-galactose and NaNO<sub>2</sub> induced memory impairment in mice. *J. Ethnopharmacol.* 104: 250-256.
- Zhang WG, Zhao R, Ren J, Ren LX, Lin JG, Liu DL, Wu YL, Yao XS (2007). Synthesis and anti-proliferative *in-vitro* activity of two natural dihydrostilbenes and their analogues. *Archiv der Pharmazie.* 340: 244-250.
- Zhang X, Xu JK, Wang J, Wang NL, Kurihara H, Kitanaka S, Yao XS (2007). Bioactive bibenzyl derivatives and fluorenones from *Dendrobium nobile*. *J. Nat. Prod.* 70: 24-28.
- Zhao W, Ye Q, Tan X, Jiang H, Li X, Chen K, Kinghorn AD (2001). Three new sesquiterpene glycosides from *Dendrobium nobile* with immunomodulatory activity. *Journal Natural Products* 64: 1196-2000.
- Zhao C, Liu Q, Halaweish F, Shao B, Ye Y, Zhao W (2003). Copacamphane, picrotoxane, and alloaromadendrane sesquiterpene glycosides and phenolic glycosides from *Dendrobium moniliforme*. *J. Nat. Prod.* 66: 1140-1143.
- Zhao JG, Feng GS, Kong XQ, Li X, Li MH, Cheng YS (2004). Changes of tumor microcirculation after transcatheter arterial chemoembolization: first pass perfusion MR imaging and Chinese ink casting in a rabbit model. *World J. Gastroenterol.* 10, 1415-1420.
- Zheng C, Feng G, Zhou R (1996). New use of *Bletilla striata* as embolizing agent in the intervention treatment of hepatic carcinoma. *Zhonghua Zhong Liu Za Zhi* 18: 305-307.
- Zheng C, Feng G, Liang H (1998). *Bletilla striata* as a vascular embolizing agent in interventional treatment of primary hepatic carcinoma. *Chinese Med. J.* 111: 1060-1063.
- Zhong HJ, Zhong JJ, Chen HY, Wang SD (2000). *Delectis florae reipublicae popularis sinicae.* 238-239.
- Zhou BH, Li XJ, Liu M, Wu Z, Ming HX (2006). Antidepressant-like activity of the *Gastrodia elata* ethanol extract in mice. *Fitoterapia* 77: 592-594.