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Review article

Piper attenuatum Buch.-Ham. ex Miq. - A review on its macroscopic characters, phytochemistry, medicinal importance and its comparative study with other *Piper* species

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ABSTRACT

The tropical plant species of family Piperaceae had been consumed from ancient time and has reputed place in the Indian Ayurvedic system as a medicine and as a spice in foods. *Piper* species are also an important part in folklore medicine of Latin America and West Indies. *Piper attenuatum* Buch.-Ham. ex Miq., an important *Piper* species, mainly found in the southern tropical and sub-tropical regions of India and is much used in the Ayurvedic system of medicine. However, there is insufficient research about the mechanisms behind the medicinal action of *P. attenuatum* but diverse pharmacological activities like antibacterial, anti-inflammatory, anti-hyperglycaemic and antioxidant are reported from various extracts of this plant. It contains various important phytochemicals like crotepoxide, piperine, guineensine and piperlonguminine which are responsible for its therapeutic efficacy. Crotepoxide is reported to exhibit significant antitumor activity. The seed extract is reported to have antioxidant activity. Piperine is reported to increase the bioavailability of other drugs by interacting with various enzymes responsible for metabolism. The current article provides an updated literature review on recent advancement on pharmacognosy, chemistry and pharmacological activities of *P. attenuatum*.

INTRODUCTION

Natural products have been practiced since prehistoric times for the treatment of many human infectious diseases and illnesses. Ayurveda, traditional Chinese medicine (TCM), Kampo, traditional Korean medicine (TKM), and Unani systems are utilizing natural products all over the world for hundreds or even thousands of years. Most of the currently available drugs for the treatment of various human and animal diseases are obtained of developed (through getting lead from natural sources) from natural products especially medicinal plants (Mishra & Tiwari, 2011). Such medications have been discovered after detecting the medicinal utilization of a specific plant or its parts (leaves, roots, barks, fruits or seed or whole plant) by botanists, and subsequent isolation of bioactive compounds from the plant or part of the plant that was utilized generally for the treatment of various human sicknesses. Natural products still continue to provide exceptional structural diversity in comparison to standard combinatorial chemistry, which presents opportunities for discovering novel lead compounds (Dias et al., 2012).

Cancer is a major worldwide health problem generally due to the lack of widespread and comprehensive early detection methods. Thus, the struggle to combat cancer is one of the greatest challenges of mankind. In spite of modern techniques and therapeutics, we are unable to combat cancer and alternatives therapies are needed (Ohlyan et al., 2013). From the last 40 years, small organic molecules derived naturally from microbes and plants have provided a number of useful cancer chemotherapeutic drugs. The search for naturally occurring lead compounds of this type has continued in recent years, with the constituents from terrestrial microorganisms and plants being investigated for their anti-cancer activities. Some antitumor agents widely used throughout the world are plant-derived compounds, including, the bisindole (Vinca) alkaloids, the camptothecins, the epipodophyllo-toxins, and the taxanes (Kinghorn et al., 2009).

Piper plants (Piperaceae) constitutes one major class of medicinal plants commonly used as a food in almost all Indian and African regions and are a potential source of drugs based on the use of some Piper species in traditional medicine. The most generally perceived types of the class *Piper* will be *P. nigrum* followed by *P. longum, P. caninum, P. mullesua, P. lolot, P. argyrophyllum, P. attenuatum, P. umbellatum, P. colubrinum* and *P. chaba.* They have been known as oriental therapeutic plants and reported to possess different pharmacological activities like anti-inflammatory, anti-bacterial, anti-hypertensive, antiplatelet, hepatoprotective, anti-thyroid, insecticidal, and anti-tumor (Núñez et al., 2005; Gupta et al., 2010; Khushbu et al., 2011; Dung et al., 2014).

The phytoconstituent acquired from different Piper species were described by classifying them into typical classes of compounds such as chromenes, amides, phenylpropanoids, terpenes, benzoic acids, lignans, flavonoids, phenolic and a series of alkaloids. The chemistry of Piper species has been studied by chemists and botanists. Piperamides are secondary pungent metabolites present in the external part of the fruits, seeds of black pepper (*P. nigrum*) and other developed assortments and species (Govindarajan et al., 1977). Their fruits, leaves and other plant parts are the ingredients of numerous formulations utilized in the Indian traditional system of medicines (Parmar et al., 1997). Piperine is the primary amide to be separated from the plants of Piper species followed by Piperlonguminine and Piperlongumine, as the significant alkaloids (Wu et al., 2004; Bezerra et al., 2013).

Piper attenuatum (fruit) is another species of *Piper* which has significant pharmacological profile; however, not much data is available on the biological profile of *P. attenuatum*. Due to the current interest, in this review, we listed the pharmacognostic and biological profile of *P. attenuatum*.

DISCUSSION ABOUT THE GENUS *PIPER*

History of the genus

Piper species had been used in traditional medicinal systems from thousands of years, including Indian and Chinese systems, as well as in folklore medicines of Latin America and West Indies (Kirtikar and Basu, 1993). Cookery use of pepper plants is proven as early as 9,000 years ago. The remains of peppercorn were found among the food refuse left by Hoabinhian artisans at Spirit Cave, Thailand. Still, there are not sufficient proofs that these plants of Piper were purposely grown in spite of collection from the forest (C. Gorman, 1971; C. F. Gorman, 1969). Peppercorns are used as pungent spice significantly on an international scale. In ancient times, the vital trade of spices including black pepper (*P. nigrum*) from South Asia to Europe was done. The Apicius (a recipe collection book), mentions "pepper" as a spice for most main dishes. Other than the use of the seeds of Piper in cooking like spices, West African Pepper leaves, known locally as uziza, are used as flavouring vegetable in Nigerian stews. Mexican pepper leaves (*P. auritum*) are used for flavour too. In Southeast Asia, leaves of two species of Piper: lolot (*P. lolot*), used to wrap meat for grilling and wild betel (*P. sarmentosum*), used raw or cooked as a vegetable have major importance in cooking (Solomon & Solomon, 2010). A few Piper animal varieties from India, Southeast Asia and Africa are of high business, restorative and monetary significance since they are utilized as flavors.

Distribution

The Piper genus is pantropical and has about 1000-2000 species in the World and 93 of them exist in Costa Rica Only (Fleming, 1983). Piper plants are generally found in humid and forested areas within the underwood of rainforests. The greatest diversity of Piper species is found in the Neotropics, where about two-thirds of the mentioned species are found.

Around 300 species are endemic to Southeast Asia, including the East Indian islands and northern Australia. Only two species are native to Africa (Marquis, 2004). In India, Kerala State produces 97% of India's total output in black pepper and is known as the land of Black pepper. There are about 16 species of pepper exist only in Kerala (Parthasarathy et al., 2006). Other states include Tamil Nadu, Karnataka, Andhra Pradesh and South region of India.

Piper is found from sea level to at least 2,000 meters in elevation. Most pipers are terrestrial, existing as small herbs, small trees, shrubs of about 2-3 meters high, and some as lianas (Fleming, 1983).

Important species and bioactive compounds

For nearly five decades, investigations into natural products chemistry of genus Piper have led to identification of structurally & pharmacologically important scaffolds that have spurred novel synthetic methodology and inspired many chemists and biochemists to speculate on plausible biogenetic relationships among these diverse skeletal (Parmar et al., 1997; Parmar et al., 1998). Some of the piper species and isolated compounds from them are reported in Table 1.

Table 1. Phytochemicals from *Piper* species

Species	Plant part/ extract	Compound isolated
P. acutisleginum	Stems + leaves Petroleum ether extract	β-Sitosterol
	Dichloromethane extract	Piperlonguminine
P. betle	Leaves Petroleum ether extract	Beta-Sitosterol Tritriacontane Stearic acid
	Stems Petroleum ether + Dichloromethane extract	Piperine Piperlonguminine β-Sitosterol
	Roots Petroleum ether + Dichloromethane extract	β-Sitosterol β-Sitosteryl palmitate
P. attenuatum	Stems + leaves Petroleum ether extract	β-Sitosterol Kadsurin A Kadsurin B Crotepoxide 14-Benzo[1,3]dioxol-5-yl-tetradecan-2-ol
P. brachystachyum	Stems + leaves Petroleum ether extract	Sesamine (+)-Asarinine β-Sitosterol Elemicin
	Dichloromethane-methanol extract	β-Sitosterol 3-(3,4-Dimethoxyphenyl)-propanoylpyrrole
	Fruits Petroleum ether extract	β-Sitosterol Parsley apiole
P. falconeri	Leaves Petroleum ether extract	Nerolidol
P. longum	Stems + Leaves Petroleum ether extract	Asarinin Guineensine Retrofractamide A
P. manii	Stems Petroleum ether extract	Retrofractamide A Apigenin dimethyl ether
	Fruits Petroleum ether extract	Tetratriacontanol
P. thomsoni	Stems + leaves Petrol extract	Dotriacontanol Dotriacontanoic acid
	Dichloromethane-methanol Extract	(-)-Galbelgin β-Sitosterol Piperine Cepharadione A

Anticancer potential of *Piper* species

Extracts from Piper species are also found to have potent cytotoxic activity. Wang et al. (2014) reported the cytotoxic potential of extracts of 24 species of Piper genus. In literature, various piper species have been reported to have anticancer potential (Table 2).

Table 2. Piper species having anticancer potential

Latin name	Part used	Country	Use	Reference
P. aduncum L.	Unknown	Mexico	Skin tumors	Calderón et al., 2006; Alonso-Castro et al., 2011
P. boehmeriifolium Wall.	Root	India	Tumor	Mahanta et al., 1974; Tang et al., 2010; Kuete et al., 2013)
P. capense L. f.	Unknown	Cameroon	Cancer	Kuete et al., 2011; Kuete et al., 2013
P. cubeba L.	Seeds	Morocco	Cancer	Daoudi et al., 2013
P. guineense Schum and *Thonn*	Seed	Nigeria, Cameroon	Cancer	Soladoye et al., 2010
P. longum L.	Leaf	Cook	Breast cancer/	Kim, K. H. et al., 2011

		Island, India	Tumor	
P. nigrum L.	Root, Fruit	Thailand, China	Abdominal tumors/ respiratory or gastric cancers	Xin et al., 2009
P. sylvaticum Roxb.	Root	India	Tumor	Kim, K. H. et al., 2011

Piper aduncum is traditionally used to treat dermatological conditions and skin tumors in Mexico (Alonso-Castro et al., 2011). Piperaduncin A (**1**) a dihydrochalcone compound isolated from this plant, exhibited growth inhibitory activity against human nasopharynx carcinoma (KB) cells with IC_{50} value of 2.3 μg/ml (Orjala et al., 1994). On other hand dichloromethane extracts of *P. aduncum* leaf were not found potential cytotoxic to various cell lines (Calderón et al., 2006). The roots of *P. boehmeriifolium* Wall and *Piper sylvaticum* Roxb. are reported for their anthelmintic, laxative, and carminative properties, as well as to diseases of the spleen, and tumors in the Ayurvedic system of Indian medicine (Mahanta et al., 1974). 1-[(9E)-10-(3,4-methylenedioxy-phenyl)- 9-decenoyl] pyrrolidine (**2**), a cytotoxic amide alkaloid isolated from the plant of *P. boehmeriifolium* was reported to have an IC_{50} of 2.7 μg/ml against human cervix adenocarcinoma (HeLa) cells (Tang et al., 2010), while piplartine (also an amide alkaloid) (**3**) (Fig. 2.2) is responsible for the anticancer effect of *P. sylvaticum* (Bezerra et al., 2013). *Piper capense* L.f. is also reported to treat cancer in Cameroon (Kuete *et al.*, 2013). Methanolic extracts of the seed are cytotoxic toward many tumor cell lines and Piperine (**4**) might be an active constituent responsible for its cytotoxic potential (Kuete et al., 2011; Umadevi et al., 2013).

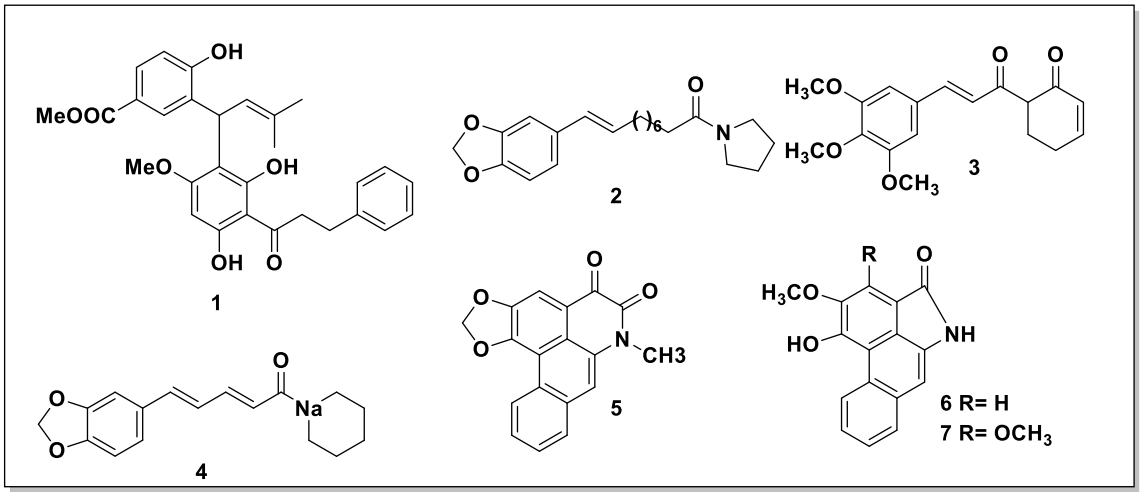


Fig. 1. Various active constituents of *Piper* species reported for anticancer activity

Piper cubeba was found one of the most important plants against cancer in *in vitro* activity of some plants used in Moroccan traditional medicine (Daoudi et al., 2013). Various studies showed that (-)-Cubebin, a major constituent of *P. cubeba* have potential therapeutic use against prostate cancer growth by targeting multiple aspects of the androgen-signaling pathway (Usia et al., 2005; Yam et al., 2008). Nigerian plant species of piper known as *Piper guineense* Schum and Thonn are reported to have anticancer properties (Soladoye *et al.*, 2010). However, the active constituents of these species are still unknown but a methanolic extract of its seed was found cytotoxic against leukemia CEM/ADR5000 cells with IC_{50} value of 8.20 μg/ml) in a study performed at Morocco (Kuete *et al.*, 2011). *Piper longum* L. is the most well-known species of piper genus and medicinal plant. In traditional medical practices, 12 leaves of this plant and 12 leaves of *Thespesia populnea* (L.) are crushed in a wooden bowl with little water and the chest of a person with suspected breast cancer is washed with this solution (Holdsworth, 1991). *P. longum* is also reported in Indian Ayurveda to treat tumors. The major active principles reported of this plant are Piplartine, cepharadione A (**5**), and piperolactams A (**6**) and B (**7**) (Kim et al., 2011). *Piper nigrum* L. (black pepper), in various forms is applied to abdominal tumors. Black pepper is also used in various formulae to treat respiratory or gastric cancers in China (Xin et al., 2009).

DISCUSSION ABOUT *PIPER ATTENUATUM* SPECIES

Indian medicinal plant *Piper attenuatum* (Buch-Ham) has a place with the family Piperaceae is found in Vishakhapatnam of Andhra Pradesh and Madurai and Tirunnelveli of Tamil Nadu. It is a substitute for black pepper (*P. nigrum*). Distinctive

parts of *P. attenuatum* have been utilized as herbal medicine for the treatment of muscular pain, headache and have been utilized as a rubefacient. The wood from the plant has been used to treat throat pain (Ohlyan et al., 2014). The root part has diuretic activity. Leaves have been utilized for their wound healing property. The entire plant is reported to contain an uncommon phytoconstituent crotepoxide, which has been reported to exhibit significant antitumor activity against Lewis lung carcinoma cell line (Kupchan et al., 1969). Phytochemical studies have demonstrated that the plant contains pipoxide and chlorohydrins which are major chemical components. (−)-galbelgin and another aliphatic liquor; 8-hentriacontanol have additionally been segregated from the leaves of *P. attenuatum*. A few aristolactams have been reported from the aerial parts of the plant. Roots have been reported to contain alkamides including piperine, guineensine and *Piper longuminine*. The petroleum extract of stems and leaves of *P. attenuatum* have been reported to contain a novel long chain alcohol, 14-benzo [1, 3] dioxol-5-yl-tetradecan-2-ol (Parmar et al., 1998). Recently methanol extract of dry fruits has also been reported to contain antioxidant components with promising activity (Ohlyan et al., 2013).

This plant is also known by its various synonyms such as *Chavica diffusa* (Vahl) Miq., *Piper malamiris* Roxb., *Piper Karok* Blume, *Piper diffusum* Vahl (Hassler, 2000; Sasikumar *et al.*, 1999). Its common names are Flat-branched pepper, oval-leaved pepper plant in English, Kattumulaka in Malayalam and arenukam and kattu-milaku in Tamil. The plant is distributed in Java, peninsular Malaysia, New Guinea (alpine), India, China (Yunnan), Bhutan, Sikkim and Myanmar (Kachin, Mandalay, Sagaing, Yangon) (Sasikumar et al., 1999).

Macroscopic characters of *Piper attenuatum*

The colour of the plant is grayish black. The taste is pungent without any characteristic odor. The plant has globular dry fruits with few striations with the average diameter of 4-6 mm (Sasikumar et al., 1999).

Microscopic characters of *Piper attenuatum*

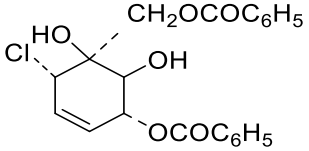
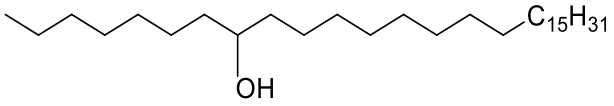
The plant is shrubby root-climber, up to 2.5 m long. Stem and branches hefty, however, delicate, end up compacted notched when dry, greenish-yellow, glabrous, bring down internodes 8.0 – 8.5 cm, upper 2.0 – 3.5 cm long; stipules 0.5 – 0.65 cm, subulate. Lamina comprehensively cordate; bring down 8.0 – 9.5 x 7.0 – 10 cm, somewhat more extensive than length, orbicular-ovate; upper 4.5-7.0 x 2.5 – 5.0 cm, whole, pellucid, intense to taper with a mucro, base cordate-truncate, membranous, relatively glabrous above, hairy on veins, nerves for the most part 7, sometimes 7 – 9 from base, laterals disparate aside from center; petioles 2.5 – 6.5 cm long, angled, greenish-yellow, hairy upwards; plants dioecious; male spike c 0.03 cm long, clustered; Stamens 3, sessile, adnate to elongated basifixed bracts (1.0 – 0.2 cm), winged, decurrent (4.0 – 5.0 cm long) rachis; female spikes (up to 10 cm long) with adnate bracts bearing its end on ovoid ovary (0.05 cm long); stigma obscurely 4; drupes 0.2 x 0.15 cm, globose, loosely aggregated, glabrous, sessile, 0.35 – 0.4 cm across, black. Flowering and Fruiting is found in the month of August to March (Brach et al., 2006).

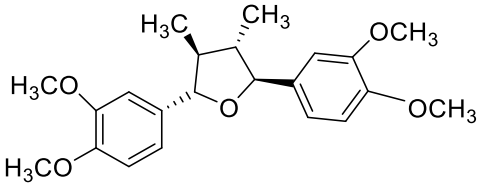
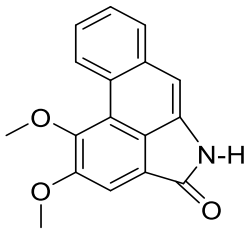
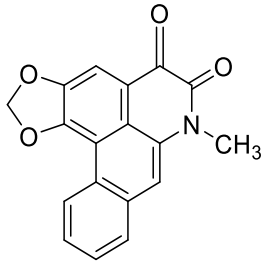
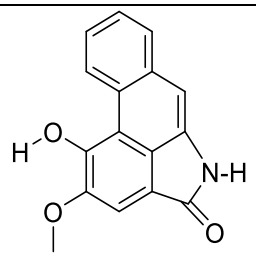
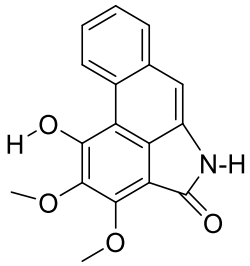
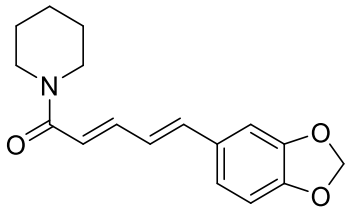
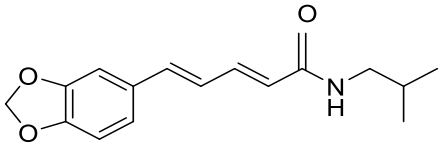
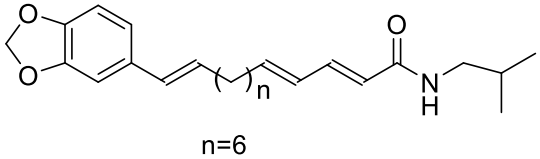
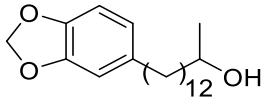
Phytochemistry

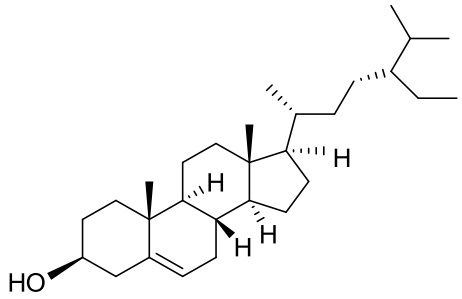
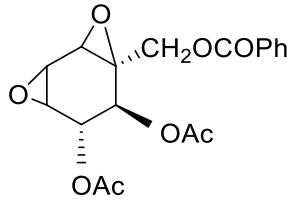
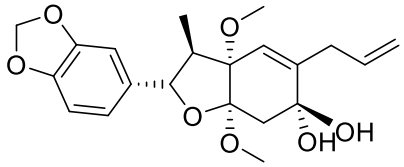
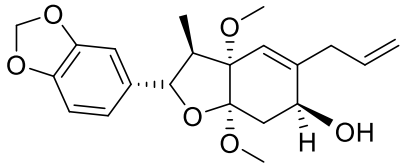
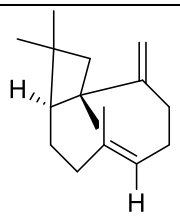
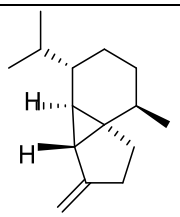
Phytochemical studies have demonstrated that the plant contains pipoxide chlorohydrins in a major amount (Joshi *et al.*, 1979) (Table 3). (−)-Galbelgin (Stevenson et al., 1977), aliphatic liquor and 8-hentriacontanol have also been isolated from the leaves of *P. attenuatum* (Sumathykutty et al., 1991). Several aristolactams such as cepharanone B, piperolactam A, piperolactam D, and cepharadione A have been reported from the aerial parts of the plant (Desai et al., 1990), (Kumar et al., 2003). Roots have been testified to contain alkamides including piperine, piperlonguminine and guineensine (Parmar et al., 1998). The petroleum extract of *P. attenuatum* have been reported to contain a novel chain alcohol, 14-Benzo [1, 3] dioxol-5-yl-tetradecan-2-ol, beta-Sitosterol, Kadsurin A, Kadsurin B and (+)-Crotepoxide (Parmar et al., 1998).

The leaf oil of *P. attenuatum* contains β-caryophyllene and β-cubebene (Sumathykutty et al., 1990).

Table 3. Chemical constituents isolated from chloroform extract of *Piper attenuatum*

Constituents	Structure	References
Pipoxide chlorohydrin		Stevenson and Williams, 1977
8-Hentriacontanol		Sumathykutty and Rao, 1991

(−)-Galbelgin		Stevenson and Williams, 1977
Cepharanone B		Desai et al., 1990; Kumar et al., 2003
Cepharadione A		Parmar et al., 1998
Piperolactam A		Desai et al., 1990; Kumar et al., 2003
Piperolactam D		Desai et al., 1990; Kumar et al., 2003
Piperine		Parmar et al., 1998
Piperlonguminine		Parmar et al., 1998
Guineensine	 n=6	Parmar et al., 1998
14-Benzo [1, 3] dioxol-5-yl-tetradecan-2-ol		Parmar et al., 1998

β-Sitosterol,		Parmar et al., 1998
(+)-Crotepoxide		Parmar et al., 1998
Kadsurin A		Parmar et al., 1998
Kadsurin B		Parmar et al., 1998
Caryophyllene		Sumathykutty and Rao, 1990
B-Cubebene		Sumathykutty and Rao, 1990

Traditional uses

Distinctive parts of *P. attenuatum* have been utilized as a herbal grown prescription for the treatment of migraine, muscular pain and have been used as a rubefacient. The wood of plant has been used to treat throat pain. The root part has diuretic activity (Ohlyan et al., 2014). Leaves have been used for their wound healing property. The entire plant is accounted to contain an uncommon phytoconstituent crotepoxide, which has been reported to show significant antitumor activity against Lewis lung carcinoma cell lines (Kupchan et al., 1969).

Pharmacological activities

Antibacterial activity

Samy et al. (1998) assessed the antibacterial activity of dry fruits of *Piper attenuatum* in which they prepared three distinct extracts by utilizing ethyl acetate, ethanol and Methanol. Each of the three extracts was screened for their antibacterial activity against *S. aureus, E. coli* and *P. aeroginosa* by agar diffusion method in which they found that Methanol extract showed comparatively good inhibition at higher doses at 200 and 500 μg against all organisms. Ethanol extract additionally demonstrated some restraint against *E. coli* at higher doses (200 and 500 μg).

Antioxidant activity

Auddy et al. (2003) explored antioxidant and anticancer activity of Indian traditional plant *Piper attenuatum*. Three extracts were prepared by utilizing ethyl acetate, ethanol and methanol. In vitro antioxidant assay was performed by ABTS free radical scavenging method. All three extracts were compared to the standard (Gallic acid) and they

found that methanol extract demonstrated highest inhibitory activity with IC_{50} of 13.17 µg which is around six-folds than that of Gallic acid (2.16 µg). Ethanol and ethyl acetate extracts also showed inhibition in concentration-dependent manner with IC_{50} of 20.35 µg and 68.06 µg, respectively

Antihyperglycemic activity

Reddy et al. (2015) examined free radicals scavenging and antihyperglycemic principles in the fruit of *Piper attenuatum.* Bioassay-guided identification of extracts having strong free radical scavenging activity and isolation of compounds was done. The chloroform extract of *P. attenuatum* having strong radical searching movement was likewise assessed for Antihyperglycemic action following oral glucose resistance test in the rodent.

Nine neolignans specifically, denudatin B (**8**), iso-4', 5'-dimethoxy-3, 4-methylenedioxy-2'-oxo-$\Delta^{'}$-8.1'-lignan (**9**), lancifolin D (**10**), denudatin A, wallichinin (**11**), piperenone (**12**), lancifolin C (**13**), 2-oxo-piperol B (**14**), piperkadsin A (**15**) and a crotepoxide (**16**) were recognized in the chloroform extract of *P. attenuatum* (Fig. 2). Assessment of free radical scavenging uncovered that all the neo-lignans showed the $ABTS^{+}$ radical scavenging activity, however, just Piperkadsin A could show $DPPH^{\cdot}$ scavenging activity. The outcomes of the study demonstrated that methoxyl groups in both of the rings present in the structure fundamentally influenced compounds' $ABTS^{+}$ radical scavenging potential as the nonappearance of methoxyl groups in crotepoxide definitely decreased its $DPPH^{\cdot}$ and $ABTS^{+}$ radical scavenging capacity.

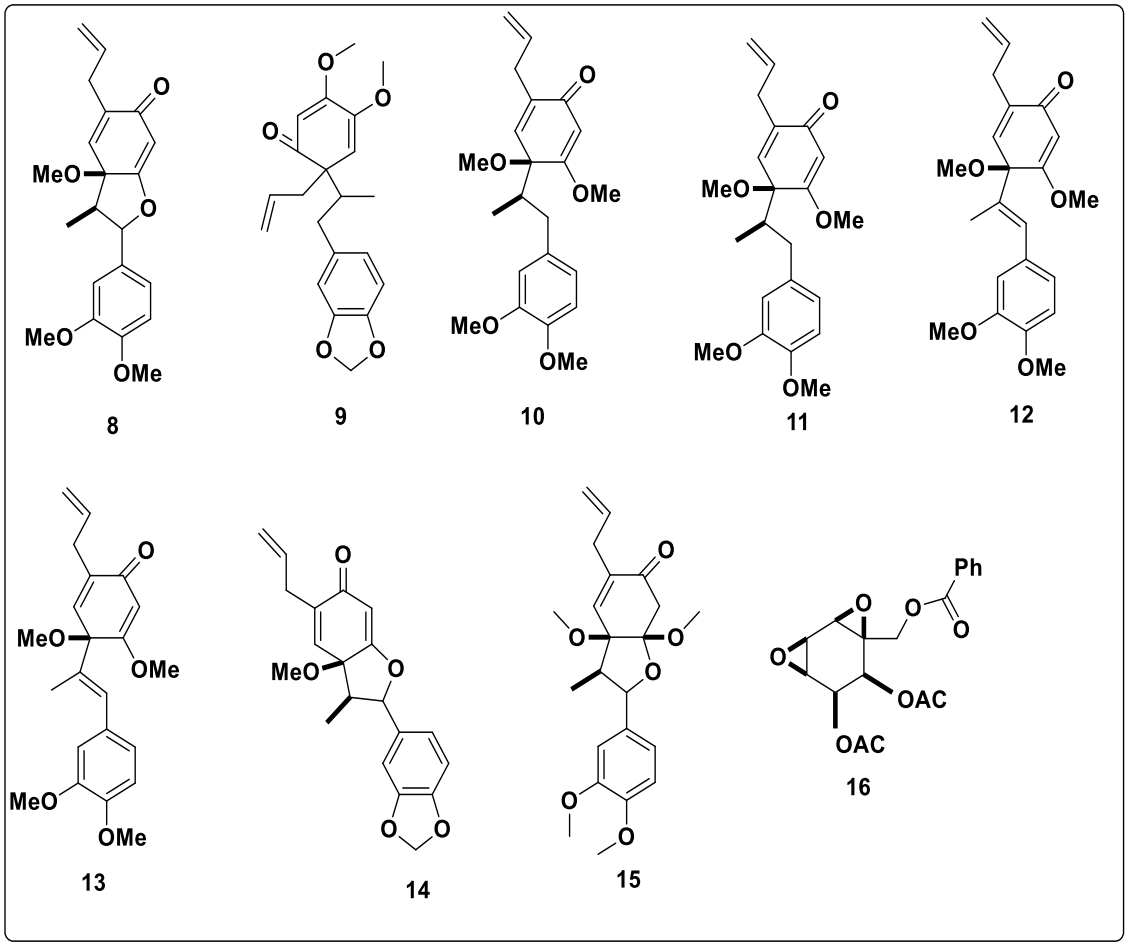


Fig. 2. Compound isolated from fruits of *P. attenuatum*

Anti-inflammatory effect

The impacts of *P. attenuatum* methanol extract (Pa-ME) on the production of inflammatory mediator nitric oxide (NO) and prostaglandin E_2 (PGE_2), the expression of proinflammatory genes, the translocation level of transcription factors, and intracellular signaling activities were investigated using macrophages. Pa-ME suppressed the production of NO and PGE_2 in lipopolysaccharide-(LPS-), pam3CSK4-, and poly (I: C)-stimulated RAW264.7 cells without displaying cytotoxicity. The mRNA articulation levels of inducible NO synthase (iNOS) and cyclooxygenase 2 (COX-2) were diminished by Pa-ME. P-ME diminished the translocation of p50/NF-κB and AP-1 (c-Jun and c-Fos), and additionally the action of their upstream catalyst Src, Syk, and TAK1. Immunoprecipitation investigation demonstrated the failure of binding between their substrates, phospho- (p-) p85 and p-MKK3/6. P-p85 and p-MKK3/6, which were prompted by overexpression of Src, Syk, and

TAK1, were likewise decreased by Pa-ME. In this manner, these outcomes recommend that Pa-ME applies its mitigating impacts by focusing on Src and Syk in the NF-κB signaling pathway and TAK1 in the AP-1 signaling pathway (Kim et al., 2017).

CONCLUSION

Ayurveda, traditional Chinese medicine (TCM), Kampo, traditional Korean medicine (TKM), and Unani systems are utilizing the natural products from hundreds or even thousands of years. Currently, most of the anticancer drugs used are obtained or derived from natural sources. Piper species also had been used in traditional medicinal systems from thousands of years, including Indian and Chinese systems, as well as in folklore medicines of Latin America and West Indies. Indian medicinal plant *P. attenuatum*, a substitute for black pepper (*P. nigrum*), is one important species of Piper. A number of original research articles are published on the pharmacological potential of *P. attenuatum*. These research studies reveal that various extracts of various parts of *P. attenuatum* possess significant *in vitro* and *in vivo* pharmacological potential for the treatment of different ailments and diseases. The wood from the plant has been used to treat throat pain. Some main constituents isolated from *P. attenuatum* like piperine, piperlonguminine are used as a muscle relaxant, CNS depressant, in headache and as insecticide agent against *Musca domestica*. The main constituents reported Piperine is reported to reduce the total body temperature and showed the analgesic, and anti-inflammatory activities. Thus it can be concluded that *P. attenuatum* is important medicinal plant of India and can be explored to get important lead for its constituents for various ailments through their identification of the mechanism of action.

CONFLICT OF INTEREST

Authors declare no conflicts of interest.

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