Review Article

An Overview of Various Piper Species for Their Biological Activities

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ABSTRACT

The genus Piper belongs to the family Piperaceae and has more than 2000 species. These plants are found almost all over the world. Some of these species are also found in India. In India these plants are mostly available in Northern part & North-Eastern part such as Himachal Pradesh, Arunachal Pradesh, Khasi and Jayantia hills of Meghalaya, Assam, Manipur. Piper is mostly known for its commercial, economical and medicinal importance. These plants contain many chemical constituents such as pipereidine, chavicin, starch, protein, cineole, p-cymene, lignin, sesquiterpenes, piperlotine, benzoic acid derivatives, schimiditin and carvone; even volatile oils such as terpenes, phellandrene, caryophyllene, piperonal-dihydrocarbeol and caryophyllene oxide are found to be very rich in these plants. Various activities such as antifeeding, antibacterial, antifungal, antiinflammatory, antiamoebic, antiplatelets, insecticidal, antioxidant, cytotoxic, antiplasmodial, DNA damaging activities etc. are manifested by these plants. These plants are being utilized by many traditional medicinal system like Traditional Chinese Medicine, Indian Ayurvedic system and folklore medicine of Latin America. Some of these species are very much useful in preparation of spices like *Piper nigrum which* is known as the King of Spices and also enhance the bioavailability of food and drugs as a carminative. The fruits of Piper are used for the treatment of various diseases of respiratory tract viz. cough, bronchitis, asthma.

Keywords: Antimicrobial activity, ant-repellent activity, cytotoxic activity, insecticidal activity, piper, piperine

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INTRODUCTION

A large number of natural products are being used as traditional medicine in several countries for the treatment of various diseases [1]. The genus Piper belongs to the family Piperaceae and has over 2000 species [2]. The plant is indigenous to India. It grows wild mostly in Himachal Pradesh, Arunachal Pradesh, Khasi and Jayantia hills of Meghalaya, Assam and Manipur [3]. These plants grow in the form of erect or scadent (climbing) herbs, shrubs, or less frequently trees [1]. Piper species have been used in variety of traditional medicinal systems such as Traditional Chinese Medicine, the Indian Ayurvedic system and folklore medicine of Latin America and West Indies [4]. The plants of genus Piper are also used for many other purposes such as foods and spices, fish bait, fish poison, hallucinogens, insecticides, oils, ornaments, perfumes etc [1]. Piper species are of high commercial and economical importance such as *Piper nigrum,* it has world-wide spice market [5]. The phytoconstituents obtained from Piper species are characterized by the production of typical classes of compounds such as amides, benzoic acids, chromenes, terpenes, phenylpropanoids, lignans, other phenolics and a series of alkaloids [1]. They have shown antifeeding [3], antibacterial [6,7], antifungal [8,9], antiplatelet [10,11], antioxidant [11], anti-inflammatory [12], antiamoebic [13], insecticidal [14-16], cytotoxic [17-20], antiplasmodial [21] and DNA damaging activities [4].

Description

The different species of Piper are largely distributed in tropical and subtropical region of the world [22]. The plant is a

woody vine in nature and may ascend up to 20 feet. The plant is cultivated in India and other countries like Nepal, Indonesia, Sri Lanka, Brazil, Malaysia, Sumatra, China etc. The stems of the plant are mostly prostrate and thickened at nodes. The plant can be propagated either by cuttings or by seeds during rainy season. It starts bearing fruits after 7 to 8 years which can also survive up to 100 years [2].

Black pepper is initially green which become yellowish orange and finally turn to red when ripped. They are round-shaped with scar of stigmas at apex of each fruit. The surface of dried Piper fruit is uneven and wrinkled. It has an aromatic odour and pungent taste. The seeds have few testa floury albumen and hardened periphery [2].

Fig. 1: ***Piper caninum***

Fig. 2*: Piper nigrum*

Fig. 3: ***Piper lolot***

Fig.4: ***Piper mullesua***

Phytochemistry

The literature survey had shown various phytoconstituents of different species of Piper where it was reported that black pepper contains piperine, pipereidine, chavicin, starch, protein, phellandrene, caryophyllene, cineole, p-cymene and carvone. Piperine was isolated as the main alkaloid from pepper. The presence of volatile oil consisting of terpenes, phellandrene, caryophyllene, piperonal-dihydrocarbeol and caryophyllene oxidesabenene, myrecene, limonene, ∝ & β pinenes, ∝-benganotene, humulene, p-cymene and ∝-selinene in *Piper nigrum* was also reported. Lignans cubebin was found only in *Piper cubeba*. Vitexin and marginatoside were found in the leaves of

Piper marginatum [2]. Myristicin, asarinin, sesamin and fargesin were found in *Piper mullesua* [3]. The presence of hydroxychavicol acetate, allylprocatechol-piperbetol, eugenol, isoeugenol, safrol, anethole, stearic acid, methyl eugenol, carvacrol, polyphenol, alkaloids, saponin, tannin, steroids and other compounds like chavicol, chavibetol, allylpyrocatechol, chavibetol acetate in *Piper betle* were mentioned [22]. The compound such as piperlotine A, piperlotine C, cinnamoylpyrrolidine, sermentine, pellitorine were found in *Piper lolot* [10, 11]. The presence of new benzoic acid derivatives crassinervic acid, aduncumene, hostmaniane and gaudichaudianic acid in *P. crassinervium, P. aduncum,* P. hostmaniannum and *P. gaudichaudianum* were reported [23]. The presence of tembamide acetate and alatamide into aerial parts of *Piper guayranum* were well documented [24]. The compounds such as pyridine alkaloid, piplartine and piplartine dimer were found in *Piper aborescens* [17].

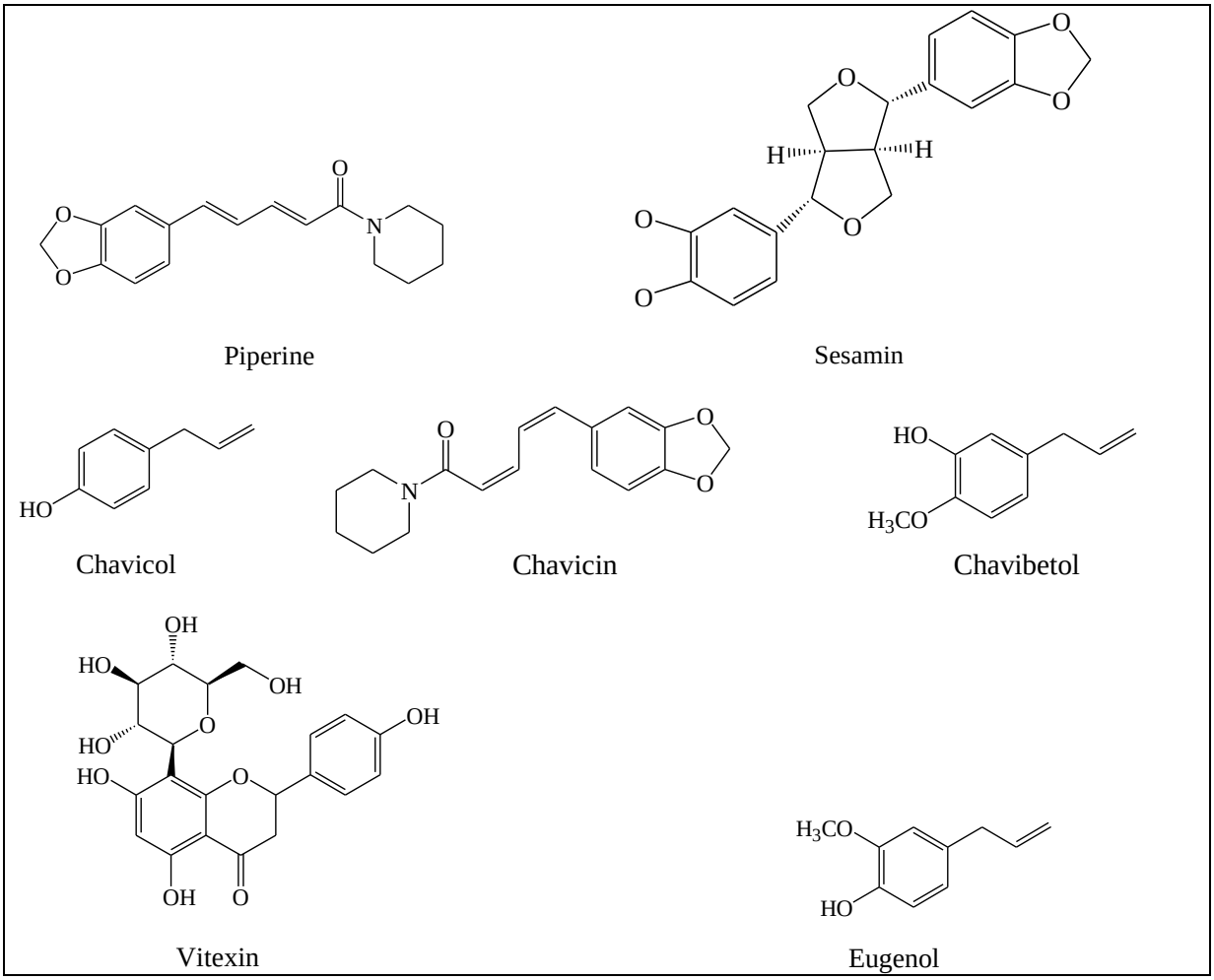


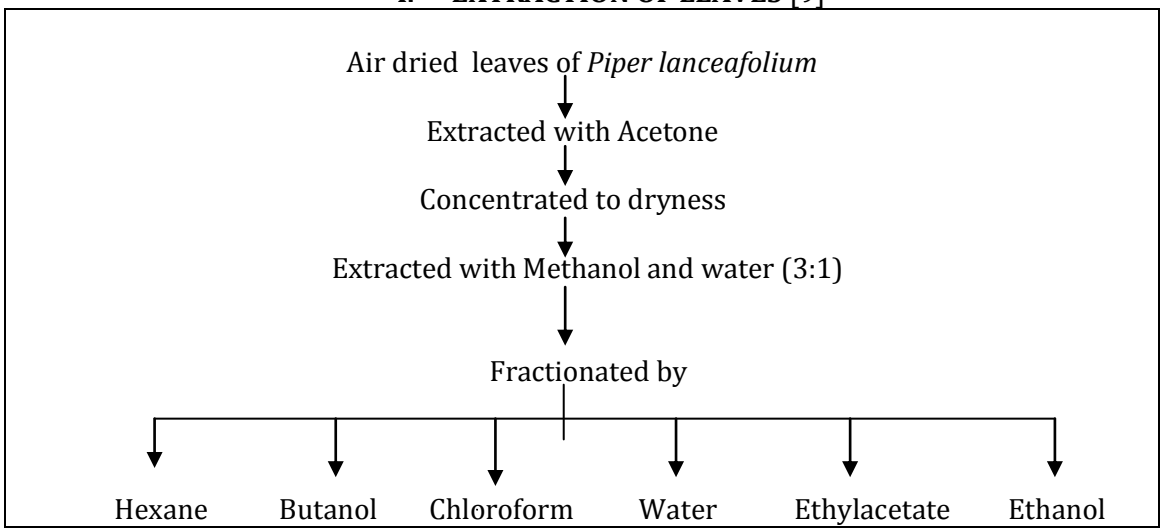
Fig. 5: Structure of Phytoconstitutents

The presence of volatile oil, resin, alkaloids, calcium, phosphorous and iron into fruits of Piper were reported [2]. The components such as taboganic acid, pinocembrin, pinocembrinchalcone, lanceaefolic acid methyl ester in *Piper lanceafolium* were mentioned [9]. The presence of sakuranetin, anodendroic acid methyl ester and carotenoid lutein in *Piper aduncum* were reported [7].

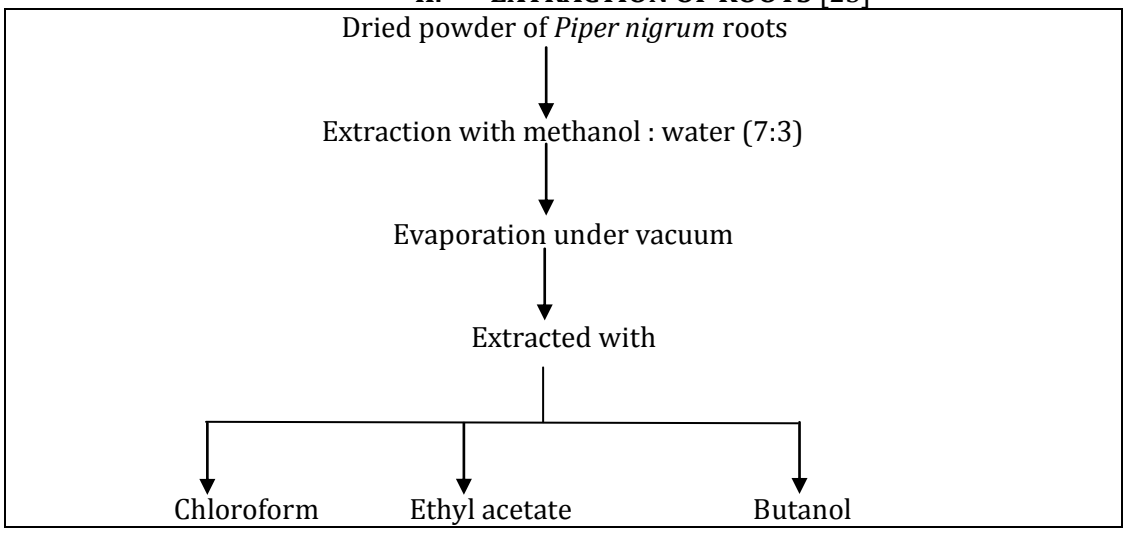
Extraction

The solvents such as ethanol, methanol, chloroform, n-hexane, ethyl acetate, dichloromethane, acetone, petroleum ether, benzene and water were used for the extraction of various plant parts of Piper. Here the extraction scheme of different plant parts of Piper obtained from literature survey was shown below:

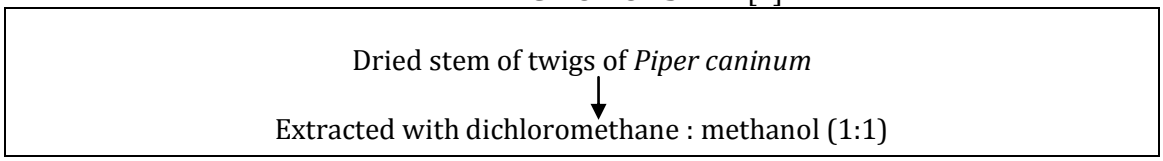
I. EXTRACTION OF LEAVES [9]



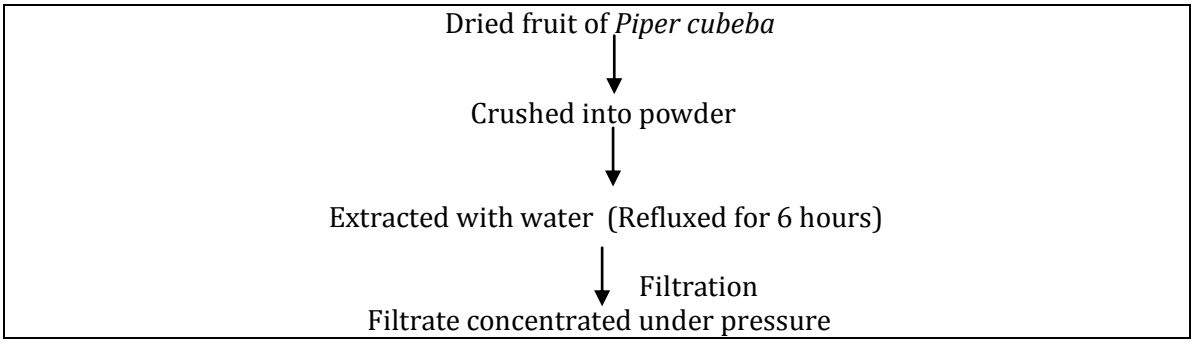
II. EXTRACTION OF ROOTS [25]



III. EXTRACTION OF STEM [4]



IV. EXTRACTION OF FRUIT [26]



The purification of fractions was done by silica gel column chromatography method with hexane-ethyl acetate and methanol.

Biological Activities

Antifeeding activity: Srivastav S *et al.* reported the ethanolic extract of *Piper mullesua* showed antifeeding activity against *Spilarctia obliqua* [3].

Clastogenecity: Junqueira APF *et al.* conducted an experiment to investigate the mutagenic potential of the crude extract of *Piper cubeba* seeds where peripheral blood and hepatic cells were collected for the comet assay and the bone marrow cells were collected for the micronucleus test [1].

Antimicrobial activity: Lugar P *et al.* investigated antimicrobial activity of the extract of the *Piper lolot* using n-hexane as a solvent. It was found that compound 3-(4'-Methoxyphenyl) propanoyl pyrrol of *Piper lolot* had shown antibacterial activity [6]. Orjala J *et al.* reported the petroleum ether extract of leaves of *Piper gibbilimbum* had antibacterial activity against *Staphylococcus epidermidis* and *Bacillus cereus* [20]. The crude dichloromethane extract of the leaves of *Piper aduncum* was screened for its antibacterial activity against *Bacillus subtilis, Micrococcus luteus* and *Escherichia coli* [7]. Liu HX *et al.* reported antimicrobial activity against *Escherichia coli, Staphylococcus aureus and Candida albicans* of methanolic extract of *Piper nudibaccatum* [27]. Evans PH *et al.* reported antifungal activity of chloroform extract of *Piper betle* leaves against *Phytium ultimum* [8]. Alecio AC *et al.* mentioned the antifungal activity against *C. sphaerospermum* of dichloromethane extract of *Piper hispidum* leaves [9]. Lago JHG *et al.* reported antifungal activity of methanolic extract of *Piper crassinervium* leaves against *C. cladosporioides and Cladosporium sphaerospermum* [23].

Antiplatelet activity: Lei D *et al.* reported antiplatelet activity of aqueous extract of inflorescence *Piper betle,* where inflorescence *Piper betle* inhibited the arachidonic acid induced and collagen-induced platelet aggregation [11]. Li CY *et al.* also mentioned that the methanolic extract of *Piper lolot* showed potent inhibitory activity on platelet aggregation [10].

CYP3A4 inhibitory effect: Usia T *et al.* mentioned the potent inhibitory activity of aqueous extract of *Piper cubeba* on the metabolism mediated by CYP3A4 enzyme. Human liver microsome was used for CYP inhibitory assay. The inhibitory activity on the metabolism mediated by CYP3A4 in vitro was determined using a radiometric measurement [26].

Insecticidal activity: Jensen HR *et al.* mentioned insecticidal activity of ethyl acetate extract of *Piper nigrum* seeds [14]. Chauret DC *et al.* reported insecticidal activity of ethanolic extract of *Piper decurrens* leaves [15]. Miranda RP *et al.* conducted a study of chloroform extract of *Piper gunacastensis* leaves for its insecticidal activity [16].

Antiamoebic activity: Joshi N*et al.* reported antiamoebic activity of hexane fraction of ethanolic extract of *Piper schimidtii* [13].

Antioxidant activity: Lei D *et al.* mentioned antioxidant activity of aqueous extract of *Piper betle* inflorescence [11].

DNA damaging activity: Ma J *et al.* reported DNA damaging activity of dichloromethane–methanol (1:1) extract of *Piper caninum* [4].

Cytotoxic activity: Duh CY *et al.* reported cytotoxic activity of chloroform extracts of *Piper aborescens* leaves [17]. Tang GH *et al.* mentioned cytotoxic activity of amide alkaloid obtained from methanolic extract of *Piper boehmeriaefolium* [18]. Pan L *et al.* reported cytotoxic activity of chloroform extract of *Piper sermentosum* [19]. Mata R *et al.* reported cytotoxic activity of dichloromethane–methanol (1:1) extract of *Piper sanctum* leaves [28].

Anti-inflammatory activity: Lin LC *et al.* mentioned anti-inflammatory activity of methanolic extract of *Piper kadsura* stem [12].

Antiplasmodial activity: Flores N *et al.* reported antiplasmodial activity against *Plasmodium falciparum* of ethanolic extract of *Piper glabratum* leaves [20].

Ant repellent activity: Capron MA *et al.* reported ant repellent activity of chloroform fraction of hexane extract of *Piper tuberculatum* leaves [29]. Green TP *et al.* also reported ant repellent activity of

chloroform extract of *Piper arieianum* leaves [30].

Table1: Biological Activities of Various Piper Species

Sl. No	Species	Solvents used	Plant part	Biological Activity
01	*Piper aborescens* [17]	Methanol Chloroform Water	Leaves	Cytotoxicity against the KB nasopharyngeal carcinoma and p-388 lymphocytic leukaemia system.
02	*Piper aduncum* [7]	Dichloromethane Petroleum ether, Ethyl acetate Methanol	Leaves	Antibacterial activity against *B. subtilis, M. luteus, E. coli*.
03	*Piper arieianum* [30]	Methanol Chloroform Water	Leaves	Ant repellent
04	*Piper betle* [8,11]	Chloroform Water	Leaves Inflorescence	Fungicidal and Nematocidal Antioxidative and Antiplatelet
05	*Piper boehmeriaefolium* [18]	Methanol Petroleum ether Chloroform	Whole Plant	Cytotoxic activity
06	*Piper caninum* [4]	Dichloro methane-Methanol (1:1)	Stem of twigs	DNA damaging activity
07	*Piper crassinervium* [23]	Methanol	Leaves	Fungitoxic activity against *C. cladosporioides* and *C. sphaerospermum*.
08	*Piper cubeba* [1,26]	Ethanol Water	Seed	Clastogenicity
		Ethyl acetate Methanol	Dried fruit	CYP3A4 inhibitory effect
09	*Piper decurrens* [15]	Ethanol	Leaves	Larvicidal activity against *O. nubilalis* and *A. atropalpus*.
10	*Piper glabratum* [21]	Ethanol Dichloromethane, Water	Leaves	Antiplasmodial activity, Leishmanicidal activity Trypnocidal activity.
11	*Piper gibbilimbum* [20]	Petroleum ether Dichloromethane Methanol	Leaves	Cytotoxicity and Antibacterial activity.
12	*Piper guanacastensis* [16]	Ethanol Hexane Chloroform Butanol	Leaves	Insecticidal activity against *Aedes atropalpus* mosquito larvae
13	*Piper hispidum* [9]	Dichloromethane	Leaves	Antifungal activity against *C. sphaerospermum.*
14	*Piper kadsura* [12]	Methanol	Stems	Antinflammatory &

		Chloroform n-Butanol Water		Immunomodulatory activity
15	*Piper lanceafolium* [31]	Acetone Hexane Chloroform Ethyl ether Ethyl acetate Methanol, Butanol and Water	Leaves	Antifungal activity
16	*Piper lolot* [6,10]	n-hexane	Rhizomes	Antibacterial activity against *B. pyocyaneus, S. aureus and B. subtilis*.
		Methanol	Leaves	Antiplatelet aggregation activity.
17	*Piper mullesua* [3]	Ethanol Hexane Chloroform and Butanol	Inflorescence	Antifeeding & Growth inhibitory effect against *S. obliqua*.
18	*Piper nigrum* [14]	Ethyl acetate	Seeds	Insecticidal
19	*Piper nudibaccatum* [27]	Methanol Petroleum ether Chloroform Water	Aerial parts	Antimicrobial activity against *E. coli* and *S. aureus.*
20	*Piper sanguineispicum* [32]	Ethanol Dichloromethane Methanol Petroleum ether, Water	Leaves	Antileishmanial activity, Cytotoxic assay.
21	*Piper sanctum* [28]	Dichloromethane Methanol	Leaves	Antimicrobial activity against *M. tuberculosis,* Cytotoxicity assay against vero cells.
22	*Piper sarmentosum* [19]	Methanol Chloroform Hexane	Aerial parts	Mitochondrial transmembrane assay, Proteasome inhibition assay, Cytotoxicity assay.
23	*Piper schimidtii* [13]	Ethanol Hexane and Chloroform	Aerial parts	Antiamoebic activity.
24	*Piper tuberculatum* [29]	Hexane Chloroform	Leaves	Ant repellent.

CONCLUSION

From the present study it has been observed that many medicinally active species of Piper are available all over the world. These can be beneficially used for the treatment of different types of ailments. These plants are mainly used as antibacterial, antifungal, antiplatelets, insecticidal, antioxidants, ant-repellent, antiamoebic, antifeeding, anti-inflammatory, antiplasmodial etc. This paper can be a guideline for those researchers who are involved in the research of different Piper species. The further study can be conducted to formulate new different forms of medicine of various Piper species. There is a great scope in studying all these natural herbs for the

development of potent pharmaceuticals in the future.

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