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Research Article

Introduction, Phytochemistry, Traditional uses and Biological Activity of Genus *Piper:* A review

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Abstract

Piper, the pepper plants or pepper vines are an economically and ecologically important genus in the family Piperaceae. It contains about 1,000-2,000 species of shrubs, herbs, and lianas, many of which are keystone species in their native habitat. *Piper* species have a pan tropical distribution, and are most commonly found in the understory of lowland tropical rainforests, but can also occur in clearings and in higher elevation life zones such as cloud forests. Most *Piper* species are either herbaceous or vines; some grow as shrubs or almost as small trees. Many species of piper have been used for treating different diseases in many traditions. E.g *P. cubeba* has been used in folk medicine, herbalism as well as in the early 20th century, as a cigarette flavoring. *P. darienense* is used medically by the Kuna people of the Panama-Colombia border region, and elsewhere it is used to intoxicate fish which then can be easily caught. Black Pepper (*P. nigrum*) essential oil is sometimes used in herbalism, and Long Pepper (*P. longum*) is similarly employed in Ayurveda, where it was an ingredient of *Triphala Guggulu* and (together with Black Pepper) of *Trikatu* pills, used for *rasayana* (rejuvenating and detoxifying) purposes.

Keywords: Piper species, Geographical Distribution, Phytochemistry, Uses, Biological Activity

INTRODUCTION

Piper betle Linn. a member of the Piperaceae family is an edible plant with leaves that have been traditionally used in India, China and Thailand for prevention of oral malodor, since it

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has anti-bacterial activity against obligate oral anaerobes responsible for halitosis. Aqueous extract of *Piper betle* has also been shown to reduce the adherence of early dental plaque bacteria[1]. Leaves of *P. betle* have a strong pungent and aromatic flavor. They are used as a mouth freshener, for their wound healing property[2], digestive and pancreatic lipase stimulant activities in traditional medicine[3]. *P. betle* leaves have also been reported to possess antioxidant [4], anti-bacterial, anti-fungal[5-7], anti-inflammatory, anti-diabetic and radioprotective activities[8]. In Thailand, *P. betle* is commonly known by its Thai name of "Phlu". Several studies have reported the antimicrobial and anti-itching activities of

P. betle. The plant has also shown an inhibitory effect on the growth of clinical isolates of *Staphylococcus aureus* (122 strains), *Escherichia coli* (31 strains) and *Pseudomonas aeruginosa* (57 strains). Recently, the ointment of the *P. betle* leaf extract has shown inhibition of growth of *S. aureus*, β-hemolytic streptococcus group A and dermatophytes, which are all microorganisms that can cause skin infection. In a clinical trial, *P. betle* ointment has cured and improved ringworm skin lesions[9]. *P. betle* gel has shown inhibition of growth of dermatophytes that cause ringworm and growth of Candida spp. more effectively than tolnaftate and with a similar inhibitory effect to that of clotrimazole. This plant has also shown an anti-pruritic effect of which is significantly greater than that of calamine lotion and similar to that of betamethasone. The principal chemical constituents of *P. betle* are chavibetol and allyl pyrocatechol, which are phenolic in nature and contribute to the anti-oxidant activity. *P. betle* extract has also shown inhibition of rabbit platelet activating factor (PAF), indicating that they are effective PAF receptor antagonists *in vitro* and may be useful for reducing allergic reactions. An ethanolic extract of *P. betle* decreases histamine production suggesting that it may be useful for relief of allergic symptoms caused by histamine in type I hypersensitive diseases [10].

Piper longum Linn. is found mainly in western ghats and central Himalayas of India. The fruits of the plant are commonly known as Pippali in Hindi and the roots as Piplamool. The roots and fruits of the plant are used as an antidote to snake bite, scorpion stings, chronic bronchitis, cough and cold. The ripe fruits are used as an alternative to tonic. The crude extract and its hexane fraction of *P. longum* exhibited antifertility effect in female rats. The fruits of piper longum have been used in traditional remedies against intestinal distress. The ethanolic, hexane and n- butanol fraction exerted *invitro* amoebicidal activity. *Piper longum* has shown caecal amoebiasis in rats[11].

Piper nigrum (black pepper) finds extensive use in Ayurvedic system of medicine. A number of piperidine and pyrrolidine alkamides are known to occur in *P. nigrum*, the most

important being piperine, known to possess a variety of biological properties like CNS stimulant, analgesic, antipyretic and antifeedant activities. Pepper is a natural spice. It is widely cultivated throughout the world and its usage as a spice is well known. *Piper nigrum* finds an extensive application in antibacterial preparations. Fractionation of the petroleum ether extract of the berries of *P. nigrum* afforded 2E, 4E,8Z-N-isobutyleicosatrienamide, pellitorine, trachyone , pergumidiene and isopiperolein B[12-16]. Pergumidiene and trachyone have also been isolated from *P. nigrum*. All the isolated compounds have shown activity against *Bacillus subtilis*, *Bacillus sphaericus*, and *Staphylococcus aureus* amongst Gram +ve bacteria, and *Klebsiella aerogenes* and *Chromobacterium violaceum* among Gram –ve bacterial strains[17].

Piper betle Linn. is a perennial dioecious, semi woody climber. It is cultivated in Sri Lanka, India, Malay Peninsula, Philippine Islands and East Africa [18]. The chief constituent of the leaves of this plant is a volatile oil known as betel oil. The volatile oil is bright yellow to dark brown liquid possessing a clove like flavor and consists of terpenes and phenols. Leaves of *Piper betle* possess several bioactivities and are used in traditional medicinal systems. The antidiabetic property of this plant has been tested in normoglycaemic and strepozotocin induced diabetic rats. The water extract in normoglycaemic rats has shown significant lowering of the blood glucose level[19].

Chemical studies carried out on Brazilian Piperaceae species have revealed the occurrence of pyrones, lignoids and chromenes besides various amides bearing
isobutyl, pyrrolidine, dihydropyridone and piperidine moieties. These amides have generated interest as a result of their potent insecticidal and antifungal properties. The structures of the several antifungal amides N-[7-(30,40-methylenedioxyphenyl)-2(Z),4(Z) heptadienoyl] pyrrolidine, (3Z,5Z)-N-isobutyl- 8-(30,40-methylenedioxyphenyl)- heptadienamide isolated from leaves of *Piper hispidum* and 8(Z)-N- (12,13,14-trimethoxycinnamoyl)-3-pyridin-2-one from *Piper tuberculatum* besides eight known antifungal amides have already been reported. Two new amides which are N-[10-(13,14-methylenedioxyphenyl)-7(E),9(Z)- pentadienoyl]-pyrrolidine, arboreumine and nine known antifungal amides N-[10- (13,14-methylenedioxyphenyl)- 7(E)-pentaenoyl]-pyrrolidine , its derivative N-[10-(13,14 methylenedioxyphenyl)-pentanoyl]- pyrrolidine and N-[10-(13,14 methylenedioxyphenyl)-7(E),9(E)-pentadienoyl]-pyrrolidine; besides pellitorine , _abdihydropiperine , piplartine, dihydropiplartine, cis-piplartine (or 8(Z)-N-(12,13, 14- trimethoxycinnamoyl)-_3-pyridin-2-one) and fagaramide have also been reported recently. In addition to these amides two cinnamoyl derivatives, methyl 6,7,8-trimethoxydihydrocinnamate and methyl trans-6,7,8-

trimethoxycinnamate have also been isolated[20-30]. The amides isolated from leaves of *Piper arboreum* and their hydrogenated derivatives are active against the fungus *Cladosporium sphaerospermum*, and the compounds isolated from seeds and leaves of *Piper tuberculatum* are also active against the fungi *Cladosporium sphaerospermum* and *C. cladosporioides* [31].

Piper regnellii is an herbaceous plant found in tropical and subtropical regions of the world[32]. Its leaf and root are used as crude extracts, infusions or plasters to treat wounds, reduction of swellings and skin irritations. Phytochemical study of *Piper regnellii* roots has shown the accumulation of several phenylpropanoids and dihydrobenzofuran neolignans including (+)-conocarpan as major compound. This compound displayed a variety of biological actives including anti-PAF[32], antifungical and insecticidal activity. The hydroalcoholic extract of *Piper regnellii* leaves has shown a strong activity against the dermatophyte fungi *Trichophyton mentagrophytes, Trichophyton rubrum*, *Microsporum canis* and *Microsporum gypseum*. Two new compounds have been isolated and identified as eupomatenoid-3 and eupomatenoid-5. These compounds in pure form showed strong activity on *Trichophyton rubrum*[33].

Piper ovatum Vahl. is an herbaceous plant found throughout Brazil, is popularly known as "joao burandi" or "anest´esica" and is used in traditional medicine for the treatment of inflammation and as an analgesic. The hydroalcoholic extract and a mixture of piperovatine and piperlonguminine in a proportion of 2:3 obtained from *Piper ovatum has been* assayed for anti-inflammatory activity[34-35]. It significantly reduced the degree of ear edema. Both the compounds when applied together shown greatest inhibitory activity on topical inflammation[36].

Piper sarmentosum Roxb. locally known by the Malays as 'Pokok Kadok' is a glabrous, creeping terrestrial herbaceous plant with aromatic odour and pungent taste, and widely distributed in the tropical and sub-tropical regions of the world, such as the Asian and South East Asia regions[37]. In Malaysia, *Piper sarmentosum* leaves and roots are applied to the forehead to relieve headache while its decoction is utilized to cure muscle weakness and pain in the bones. In Indonesia, *Piper sarmentosum* rootlets are chewed with betel nut and the juice is swallowed to treat coughs and asthma. It is also chewed with ginger to treat toothache or chewed with a little nutmeg and ginger to treat pleurisy. Warmed leaves coated with coconut oil are applied to the painful chest while the finely ground leaves mixed with small amount of water are smeared on the throat to treat coughs. In Thailand, the roots are used as carminative and stomachic[38] while the fruits and leaves are used as an expectorant. Several scientific and pharmacological studies have been carried out on the various part of the *Piper*

sarmentosum. The water extract of the whole plant of Piper sarmentosum has been assessed in normal and streptozocin-induced rats. The methanol extract of the leaves of *Piper sarmentosum* exhibited a neuromuscular blocking activity at the neuromuscular junction [39]. The antimalarial activity of chloroform extract of *Piper sarmentosum* has also been reported. The methanol extract of the root has also shown an anti-amoebic effects against Entamoeba histolytica infection in the caecum of mice. The ethanol extract of *Piper sarmentosum* possesses larvicidal effect against early 4th instar larvae of *Aedes aegypti* mosquitoes which is attributed to the extract ability to cause external destruction, with extensive damage and shrunken cuticle of the anal papillae. In addition, the ethanol extract of has also been reported to exert adulticidal activity against female mosquitoes *Stegomyia aegypti*, a main vector of dengue and dengue haemorrhagic fever, by topical application. The methanol extract of the leaves of *Piper sarmentosum* also exhibited potential antibacterial activity against both gram positive *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* and gram negative *Pseudomonas aeruginosa*. Recent study has demonstrated that various extracts of the leaves of *Piper sarmentosum* also possessed antioxidant and anti-tuberculosis activities[40]. Recently a new alkaloid has been isolated from the root and is confirmed to be (1-nitrosoimino-2,4,5-trimethoxybenzene) whci has the ability to exhibit antinociceptive activity[41].

The four acidamides, piperine, pipernonaline, piperoctadecalidine, and piperlongumine, isolated from the fruits of *Piper longum* have shown inhibition of PAF on washed rabbit platelet. Piperlongumine, in particular, is the strongest among the entire compounds[42].

The leaves of *Piper carpunya* Ruiz & Pav. (syn :*Piper lenticellosum* C.D.C.), known with the popular name of "guaviduca" in Ecuador are widely used in folk medicine in tropical and subtropical countries of South America, as an anti-inflammatory, anti-ulcer, anti-diarrheal and anti-parasitical remedy as well as
an ailment for skin irritations[43-44].

The extracts from leaves of *Piper aduncum* L. and *Piper hostmannianum* C. DC. Has been reported activite in a bioautographic screening against *Cladosporium cladosporioides* and *Cladosporium sphaerospermum*. Among Piperaceae, *P. aduncum* is the most chemically investigated species and several bioactive alkaloids, chromenes, dihydrochalcones, flavonoids, and benzoic acid derivatives have been described. *P. hostmannianum* is an endemic species to Amazon forest and it is reported to contain dihydrochalcones, flavanones, and benzoic acid derivatives as major compounds. EtOH extract from leaves of *P. aduncum*

has given three prenylated methyl benzoates including the new methyl 4-hydroxy-3-(20-hydroperoxy-30-methyl-30-butenyl)- benzoate, one flavanone, and two chromenes. The CH2Cl2:MeOH (2:1) extract of leaves of *P. hostmaniannum* has yielded prenylated methyl benzoates. The crude extracts from leaves of Brazilian species *Piper aduncum* and *Piper hostmannianum* afforded prenylated methyl benzoate, chromenes, and dihydrobenzopyran derivatives as antifungal compounds[45].

Piper obliquum Ruiz & Pavon is a shrub growing in lowland secondary rain forests of central and South America. Its leaves are utilized as analgesic or antiarthritic by topic application on the affected body part in Guyana and Ecuador, where the plant is known with the popular name of "Anis del Oriente", due to its distinct anis-like perfume. *Piper aduncum* L. also known as "matico", "aperta-ruao", "pimenta longa" or "bamboo piper" is a multi stemmed shrub of more than 5m height, native to the Caribbean but adapted to thrive through the whole tropics, often acting as a weed in disturbed habitats. It presents a wide range of traditional uses and its essential oil is a well-known insecticide, molluschicide and antibacterial. Tea made from leaves and roots is used to treat diarrhea, dysentery, nausea, ulcers, genito-urinary infections and is also traditionally utilized for the control of bleeding as an antihemorrhagic. Essential oils from aerial parts of *Piper aduncum* and *Piper obliquum* of Ecuadorian origin has been analyzed for their biological and pharmacological activities. Chemical composition of these plants is different as safrolerich (*P. obliquum)* and dillapiol (*P. aduncum*). Antimicrobial assays have been repotred on Gram +ve and Gram -ve bacteria and dermatophyte and phytopathogenic fungi. Very good results have been obtained against fungal strains [46].

Piper galeatum is indigenous to India and grows wild in the forests of Wayanad and Kerala region. Ten sesquiterpenes and monoterpenes have been reported namely, b-elemene, d-elemene, a-humulene, b-caryophyllene, a-copaene, a-ionone, 10-(acetylmethyl)-3-carene, dihydrocarvyl acetate, 1-p-menthen-8-yl acetate and linalyl acetate from the fruits extract of *P. galeatum*. The phytochemical examination of the stems of *P. galeatum* led to the isolation and characterization of four known compounds as b-sitosterol, cyclostachine-A, piperine, piperolein-B and a novel amide namely 1-(30-hydroxy-50-methoxycinnamoyl)-piperidine which has been reported for the first time from *P. galeatum*. The crude extracts as well as the isolated pure compounds have been screened for their activity to inhibit TNFa (tumour necrosis factor-a)- induced expression of cell adhesion molecule ICAM-1 (intercellular adhesion molecule-1) on the surface of human umbilical vein endothelial cells (HUVECs).

Among all, b-sitosterol has shown the maximum effect. b-sitosterol has also shown significant blockade of the adhesion of neutrophils to endothelial monolayer[47].

The anti-amoebic effects of crude methanol extracts of *Piper longum* fruit, *Piper sarmentosum* root and *Quercus infectoria* nut gall against *Entamoeba histolytica* infecting the caecum of mice has been studied. The extracts of *Piper longum* fruit, *Piper sarmentosum* root and *Quercus infectoria* nut gall has shown a curative effect as the former being the most effective[48].

Piper marginatum is the bushy aromatic shrub grows abundantly around the borders of the Atlantic forest and is known by the popular name ‘‘malvaisco” in north-eastern Brazil (Pernambuco, Paraíba and Rio Grande do Norte) and as ‘‘caapeba cheirosa” or ‘‘pimenta do mato” in the northern region, especially in the
Amazon. The plant is commonly used in Brazilian folk medicine for the treatment of inflammation, snake bites, and diseases of the liver and bile duct, whilst the fruits serve as a food, flavouring agent, often acting as a substitute for black pepper. Extracts of leaf and fruits, as well as the essential oil of the plant, have been shown to possess significant cercariacidal activity. The essential oils of leaves, stems and inflorescences of *Piper marginatum* has revealed the presence of 40 components, the most abundant being (Z)- or (E)-asarone and patchouli alcohol. The essential oil of the inflorescences exhibits potent activity against the 4th instar of *Aedes aegypti*. These properties suggest that *P. marginatum* oil is a potential source of valuable larvicidal compounds[49].

The Chinese Pharmacopoeia contains three monographs: *Piper nigrum* (‘‘Hujiao’’), *Piper longum* (‘‘Bibo’’) and *Piper kadsura* (‘‘Haifengteng’’). In addition, several other *Piper* species are commonly found in China like *Piper hancei*, *Piper futokadsura*, *Piper puberulum*, *Piper retrofractum* and *Piper wallichi.* Many species has not yet been examined like *P. boehmeriifolium* var. *tonkinense*, *Piper damiaoshaneense*, *Piper hainanense*, *Piper laetispicum*, *P. longum* var. (‘‘round peepal’’), *Piper martinii*, *Piper nudibaccatum*, *Piper ponesheense*, *Piper puberulilimbum*, *Piper pubicatulum*, *Piper semiimmersum*, *Piper spirei* and *P. wallichii*. The *n*-hexane extracts of 19 *Piper* species, predominantly from China have been screened for their 5-lipoxygenase (5-LOX) and cyclooxygenase-1 (COX-1) inhibitory potential. Many of them showed considerable inhibitory activity against at least one of these two key enzymes of the arachidonic acid metabolism, especially against COX-1. The extract of *Piper kadsura* has shown very good results in inhibiting the formation of leukotrienes. The extract of *Piper boehmeriifolium* var. *tonkinense* has shown good prostaglandin synthesis inhibitory activity. The spectroscopic data has revealed the presence of pellitorine, and four

higher homologues, piperlonguminine, dihydropiperlonguminine, futoamide, chingchengenamide, the retrofractamides A, B and D, guineensine, brachystamide B, piperanine, piperine, piperdardine, sarmentine, pipataline and benzylbenzoate in these species[50].

Piper hispidum Swingle is a shrub native to the lowlands of Mexico, a species of pan-tropical distribution, commonly found throughout both disturbed and forest sites. It is also commonly known as "cordoncillo". *Piper hispidum to* has been used to treat aches and pains in Nicaragua, to regulate menstruation in Peru, and to treat urinary infections in the Amazon. In Peru, the leaves of the plant are also traditionally used by the Chayahuitas, an Amazonian Peruvian ethnic group, to heal wounds and to treat symptoms of cutaneous leishmaniasis. In terms of chemical constituents, the plant is reported to contain amides, benzenes, benzoic acids, flavonoids and volatile oils, which have shown significant antifungal, antimicrobial, antiplasmodial, leishmanicidal and insecticidal activities. Three butenolides including one new compound as 9,10-methylenedioxy-5,6-Z-fadyenolide have been isolated from the leaves of *Piper hispidum*, and their structures have been determined. The *Piper hispidum* leaf extracts has enhanced the expression of estrogen responsive reporter and endogenous genes in MCF-7 cells, demonstrating estrogen agonist effects. Extracts of *Piper hispidum* have also acted as agonists of the ER and 5-HT7 receptors[51].

Piplartine (5,6-dihydro-1-[1-oxo-3-(3,4,5-trimethoxyphenyl)- 2-propenyl]-2(1*H*) pyridinone) is an amide alkaloid component of *Piper* species. This secondary metabolite has significant cytotoxic activity against tumor cell lines, especially human leukemia cell lines, such as HL-60, K562, Jurkat, and Molt-4, as well as antifungal, anti-platelet aggregation, anxiolytic and antidepressant properties. This molecule is isolated from *Piper tuberculatum.* Piplartine has also been studied for its genotoxicity and the induction of apoptosis by in V79 cells and its mutagenic and recombinogenic potential in *Saccharomyces cerevisiae.* Piplartine has shown cytotoxicity in *S. cerevisiae* cultures in either stationary or exponential growth phase. Piplartine treatment has also induced DNA strand breaks in V79 cells. In cell cycle analysis, Piplartine has also induced G2/M cell cycle arrest, probably as a consequence of the DNA damage induced and repair. Moreover, piplartine has also shown apoptosis in a dose-dependent manner, as observed by a decrease in mitochondrial membrane potential and an increase in internucleosomal DNA fragmentation[52].

Alcoholic extract of the fruits of the plant *Piper longum* and its component piperine has been studied for their immunomodulatory and antitumor activity. Alcoholic extract of the fruits have shown toxicity to Dalton's lymphoma ascites (DLA) cells and Ehrlich ascites

carcinoma (EAC) cells. Piperine has been found to be cytotoxic towards DLA and EAC cells. Alcoholic extract and piperine have also found to produce cytotoxicity towards L929 cells. An alcoholic extract of *Piper longum* as well as piperine has shown inhibition of the solid tumor development in mice induced with DLA cells and increases the life span of mice bearing Ehrlich ascites carcinoma tumor[53].

Light petroleum extract of the roots of *Piper guineense* Schum and Thonn has been carried out and and reported to possess insecticidal activity. This fractionation yielded five different active amides, which have been identified as N-isobutyl-1-(3,4-methylenedioxyphenyl)-2E,4E,lOE-undecatrienamide, N-pyrrolidyl-12-(3,4-methylenedioxyphenyl)- 2&4&9&l lZ-dodecatetraenamide, N-isobutyl-l3-(3,emethylenedioxyphenyl)-2E,4E,12E-tridecatrienamide, N-isobutyl-2&4&decadienamide and N-isobutyl 2&4Edodecadienamide[54].

Piper laetispicum is popularly known in folk as Xiao Chang-feng, Shan Hu-jiao, Ye Hu-jiao, is an endemic climbing, glabrous plant of the southern part of China. As a folk medicine, this plant enjoys vast uses for invigorating circulation and reducing stasis and analgesic. Laetispicine (N-isobutyl-(3,4- ethylendioxyphenyl)-2E, 4E, 9E-undecatrienoamide) is a novel alkaloid amide from *P. laetispicum*. The *P. laetispicum* extract has shown antinociceptive and antidepressant activities in several behavioral models[55].

Pharmacological investigation of hexane extract from leaf of *Piper truncatum* has been studied and reported relaxant effects on vascular and tracheal smooth muscles. The plant contains furofuran lignan eudesmin which is the main component of the hexane extract from the leaves. On the other hand, eudesmin has been isolated from different plant families, including Apiaceae , Rutaceae, Ochnaceae and Magnoliaceae. Many studies have shown its broad range of biological activities, including cytotoxic, antibacterial, antifungal and inhibitory effects on tumor necrosis factor-alpha production. In Brazilian folk medicine, extracts from this species are used to reduce blood pressure[56].

The roots of *Piper syhaticum* Roxb. are widely used as an effective antidote to snake poison in the indigenous system of Indian medicine. Seeds of this plant resulted in the isolation of a new alkamide sylvatine in addition to 4'-7- dimethoxy-5-hydroxy flavone and the extremely unstable N-isobutyl-deca-trans-2-trans-6 dienamide[57].

The aerial part of *Piper capense* L. is traditionally used in Comoro Islands for diarrhoea and cough. The antiplasmodial activity of different extracts has been evaluated *in vitro* against the chloroquine-resistant strain W2 of *Plasmodium falciparum*. The chloromethylenic extract of *P. capense* has shown moderate *in vitro* activity against *P.*

falciparum. The phytochemical studies carried out on *P. capense* have resulted in the identification of lignans, sesquiterpenes, and essential oil with high percentage of monoterpene hydrocarbons. The chloromethylenic extract of *P. capense* shown the presence of a new amide alkaloid, Kaousine together with the Z form of antiepilepsirine, the known apigenine dimethylether, and piperchabamide A, isolated for the first time from this plant. All the isolated compounds have shown *in vitro* antiparasitic activities against *Plasmodium falciparum*[58].

The leaves of *Piper sarmmtusum* are used for wrapping food in some parts of Thailand and Philippines, which suggests the existence of antimicrobial compounds in the leaves. Little is known about the chemistry of this plant. Several compounds have been isolated and identification from this plant which are of phenylpropanoids in nature and they have shown antimicrobial activitiy. One new and three known phenylpropanoids have been isolated from the leaves of this plant. The new compound showed antimicrobial activity against *Escfterichia cob* and *Bacillus subtifis*[59].

The plant *Piper chaba* is a climbing, glabrous shrub available in various parts of India and Malay Islands. In Bangladesh, it grows in plenty in Khulna division and more specifically in the Satkhira–Bagerhatt area. Like other plants of *Piper* genus, the plant enjoys vast folk uses, as traditional medicine. The root is alexiteric; useful in asthma, bronchitis, consumption. The fruit is pungent; thermogenic, anthelmintic, expectorant, carminative; improves appetite and taste and also useful in asthma, bronchitis, fever, inflammation, piles, pain in the abdomen and at the anus. The fruit has stimulant and carminative properties, and is used in haemorrhoidal infections. Stem is used to alley post-delivery pain in mothers and also useful in rheumatic pains and diarrhea. The phytochemical investigation of the stem bark of the plant revealed the presence of lignan and alkaloids such as piperamine 2,4-decadienoic acid piperidide, kusunokinin and pellitorine. Root has been reported to contain some alkamides such as piperine, sylvatine, piplartine and piperlonguminine and β-sitosterol. A novel piperine dimer called chabamide has also been indentified in the stem bark. Besides caryophyllene, caryophyllene oxide and few monoterpene hydrocarbons, a moderate content of sesquiterpenes and high amount of aliphatic hydrocarbons have been found in the fruit oil of the plant. The crude extract of the plant has shown the increase in the oral bioavailability of sulfadiazine and tetracycline hydrochloride. The crude extract has been found to possess antibacterial activity. Aqueous-acetone extract of the fruit of *Piper chaba* as well as some isolated alkamides have shown protective activity against ethanol and indomethacin induced gastric lesions in rats[60].

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