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Traditional Uses, Pharmacological Properties and Therapeutic Potential of Piper longum: A Comprehensive Overview

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ABSTRACT

Piper longum, commonly known as long pepper, is a significant medicinal plant widely used in traditional medicine systems. This perennial climber, native to India, has been valued for its potent therapeutic properties, primarily attributed to its active constituents such as piperine, piperlongumine, and essential oils. Long pepper exhibits a broad spectrum of medicinal benefits, including its use as an anti-inflammatory, analgesic, and antipyretic agent. Its efficacy in treating respiratory disorders such as asthma, bronchitis, and cough is well-documented. Piper longum is a plant with a rich history of use in traditional medicine and a growing body of scientific evidence supporting its therapeutic potential. In Ayurveda, the plant is mainly used to cure respiratory disorders. The roots of this plant are helpful to cure bronchitis, spleen diseases, stomachaches and tumor. It is used to treat diseases like krimi (parasitic disease), pliha roga (spleen disorders), kshaya (pulmonary tuberculosis), shwasa (dyspnea), urastambha (stiffness of thigh), grahni (dysentery), vatavyadhi (nervous diseases), vishama jvara (intermittent fever), arsha (piles), nidranasha (insomnia) and other disorders. Its diverse pharmacological properties, including anti-inflammatory, antioxidant, and anticancer effects, alongside its ability to enhance drug bioavailability, underscore its importance in modern medicine. P. longum is mainly used to treat respiratory disorders such as bronchitis, asthma and stomach-related disorders such as gynaec problems, indigestion, asthma, tuberculosis. Future research will be crucial in translating these findings into clinical practice.

Keywords: Anti-inflammatory, antioxidant, anticancer, pharmacological, endotoxins, bioavailability, traditional medicine.

1. INTRODUCTION

Piper longum, often called long pepper (Pippali), is a flowering vine in the Piperaceae family that is grown for its dried fruit, which is used as a condiment and spice. Similar to the more well-known black pepper (Piper nigrum), the fruit of P. longum has a distinct flavour and level of spice (Kirtikar et al., 1933). P. longum is a perennial that grows well in tropical regions. It has tiny, prickly fruits that are two to three centimetres long and has heart-shaped leaves. These fruits are picked and dried for use as a spice; they are originally green and become crimson when mature (Rastogi et al, 1993). For generations, P. longum's dried fruit has been utilised in traditional medicine and culinary, particularly in Mediterranean, Indonesian, and Indian cuisines. It is a common ingredient in spice mixes like garam masala because of its strong,

peppery flavour with a hint of sweetness. P. longum is prized for its therapeutic qualities in traditional Chinese and Ayurvedic medicine. It is said to be beneficial for digestive and respiratory disorders as well as acting as a general tonic to extend life. According to Mohapatra et al. (2015), piperine, the active ingredient, has anti-inflammatory, anticancer, analgesic, antifungal, antifertility, and antioxidant qualities. Long before black pepper became widely used, P. longum was one of the first spices used in European cooking. In antiquity and the middle Ages, it was a valuable commodity for commerce.

2. TRADITIONAL USES

P. longum is prized for its many medicinal qualities in traditional medicine. It is frequently used as a therapy for different illnesses, a digestive aid, and a cure for respiratory conditions. It is thought to improve general energy and balance the body's doshas in Ayurveda. Because it is believed to rid the body of toxins, long pepper is used in detoxification procedures. Because of its capacity to enhance liver function and cleanse blood, it is utilised in Ayurvedic Panchakarma treatments. These customary applications of P. longum show the plant's importance in prehistoric medicine and its ongoing use in modern herbal therapy (Nagatome et al., 2005).

a) Ayurvedic view: The P. longum plant has been utilised to cure a number of illnesses and conditions in the Ayurvedic medical system (Agrawal et al., 1997 and Tripathi et al., 1999). According to ancient texts, P. longum is utilised as a bioenhancer that aids in the body's removal of endotoxins. India has been using it since antiquity. In Ayurveda, it is regarded as one of the important herbs. Pippali is a major medication used to cure agnimandya and Anaha (constipation). The Charaka Samhita (Ayurved dipika, 2008). In Ayurveda, the herb is mostly used to treat respiratory disorders. The roots of this plant can be used to treat stomachaches, bronchitis, spleen problems, and tumours. It is used to treat conditions such as krimi (parasitic disease), pliha roga (spleen disorders), kshaya (pulmonary tuberculosis), shwasa (dyspnoea), urastambha (stiffness of the thigh), grahni (dysentery), vatavyadhi (nervous diseases), vishama jvara (intermittent fever), arsha (piles), nidranasha (insomnia), and others (Krutika et al., 2014). Additionally, it helps strengthen the body's immune system and digestive system and is beneficial against abdominal tumours, piles, madhumeh, colic indigestion, anaemia, cardiac, spleen disorders, Kapha disorders, flatulence, gout, paralysis, rheumatic pain, and sciatica (Manoj and Soniya, 2004). An ayurvedic contraceptive is made from P. longum fruit, powdered E. ribes seeds, and borax powder (Chaudhury and associates 2001). Rasayana treatment, which also helps to avoid COVID-19 symptoms, uses Piper longum (Subramaniam and associates 2021). The P. longum plant is employed in over 135 ayurvedic preparations, according to the stated study (Kamboj and associates 2000).

b) Folk Uses: In cuisine, P. longum is often used as a flavour or spice. P. longum has historically been used to treat stomach-related conditions such gynecological issues, indigestion, asthma, and TB as well as respiratory conditions like bronchitis and asthma (GJRMPIM, 2013). The plant's fruit works well against parasites and has anthelmintic properties. It aids in the removal of mucus from the lungs and other respiratory organs and is also used as an expectorant. Chronic bronchitis is treated with pipali mool root and fruit decoction. To cure rheumatism, the roasted fruit is administered twice a day for a month together with honey (Agarwal, 2015). To treat diabetes, the plant's fruit paste is taken once daily with a glass of water (Mishra et al., 2019). Additionally, it is utilised to treat allergy issues. To treat urticaria, the powdered fruit of the plant is consumed on an empty stomach together with mishri. Additionally, when combined with honey and tulsi drops, it is useful to treat colds and coughs (Ritu and Goraya, 2020). Additionally, the plant is used to boost appetite, strengthen memory, and aid in the recovery of health by curing illnesses.

3. CHEMICAL CONSTITUENTS

In addition to substances like methyl piperine, piperlongumine, and tetrahydropiperine, which are also present in the root, the fruit of P. longum includes a variety of alkaloids, chiefly piperine. Piperine, which makes about three to five percent of the dry weight of long pepper (P. longum), is the main active ingredient. Along with vital minerals and lipids, P. longum fruit also includes a variety of active substances, such as fatty acids and lignans. Important constituents of P. longum fruit essential oil include bisaboline (11%), pentadecane (17.8%), and caryophyllene. Compared to cousins, it has less essential oil (approximately 1%), which is made up of ethers such bisabolene and β-caryophyllene and sesquiterpene hydrocarbons (Zaveri et al, 2010).

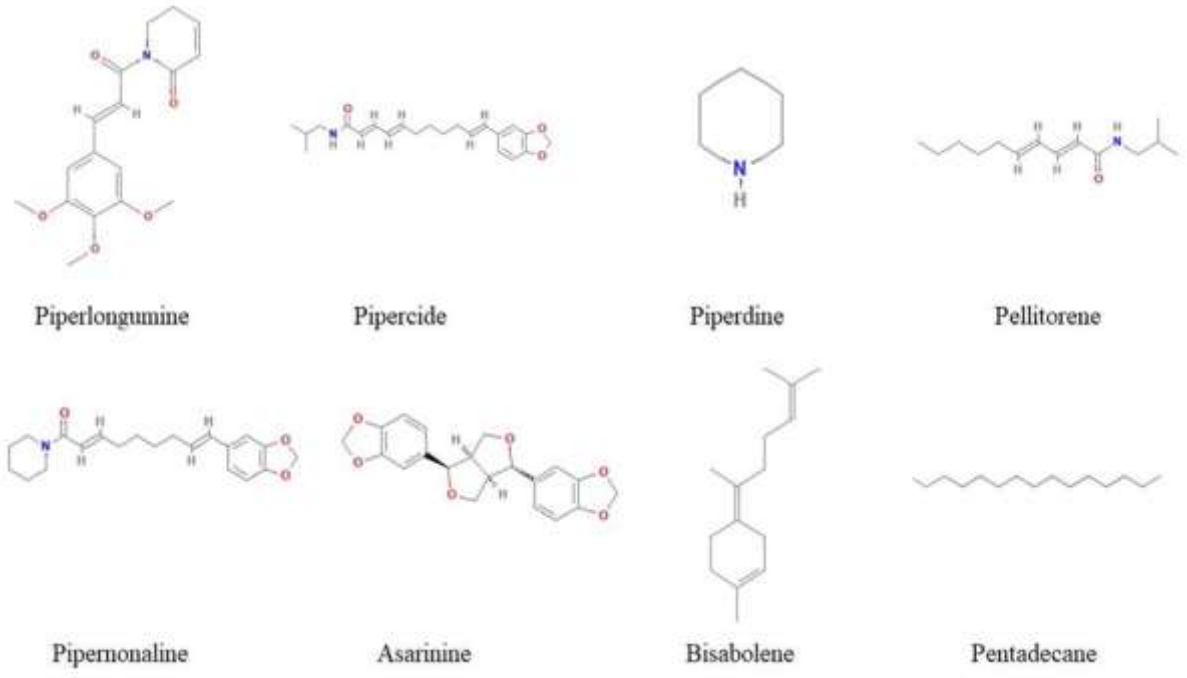

Figure 2: Chemical structures of some major phytochemical constituents of P. longum plant.

4. PHARMACOLOGICAL PROPERTIES

4.1 Anti-inflammatory Activity

P. longum has strong anti-inflammatory properties. The main active ingredient, piperine, has the potential to treat inflammatory diseases such arthritis by inhibiting pro-inflammatory cytokines and enzymes (Kumar et al., 2011). According to Yende et al. (2010), rats with induced arthritis that were fed P. longum aqueous extract at dosages of 400 mg/kg and 200 mg/kg showed a significant decrease in paw swelling. According to Devan et al. (2007), P. longum possesses anti-inflammatory and bio-enhancer qualities. In mice and human cells, the study examined the immunoregulatory potential of P. longum and piperinic acid, demonstrating decreased pro-inflammatory mediators and cytokines.

4.2 Antioxidant Activity

The plant's capacity to scavenge free radicals and strengthen cellular defence systems is responsible for its antioxidant qualities. Specifically, piperlongumine has potential in reducing oxidative stress (Srivastava, 2014). Alok et al. (2008) investigated the effects of P. longum (PLM) methanolic extract on biochemical alterations, tissue damage, and antioxidant levels in wister rats given adriamycin. For 21 days, PLM was administered at dosages of 250 mg/kg and 500 mg/kg. Adriamycin causes the heart's enzyme

activity and serum levels to drop, while the heart's lipid peroxide levels increase. Their effects were reversed by PLM pretreatment, which decreased the production of lipid peroxide and restored enzyme activity. Additionally, PLM increased the activity of antioxidant enzymes and shielded the heart's cells from adriamycin-induced cardiotoxicity.

4.3 Anti-tumor Effect

Studies show that P. longum and its components have anticancer qualities. Piperine has direct cytotoxic effects on a variety of cancer cell types and increases the absorption of chemotherapy drugs. According to Sunila et al. (2004), the fruit P. longum's alcoholic extract and piperine, its active ingredient, have immunodulatory and anticancer properties. Alcoholic extract of P. longum (10 mg/dose/animal) and piperine (1.14 mg/dose/animal) prolonged the lives of Ehrlich ascites carcinoma tumor-bearing mice to 37.3 and 58.8%, respectively, in mice produced using DLA cells. According to Bezerra et al. (2008), piperine's alkaloids exhibit anticancer properties. Histopathological analysis reveals that the kidney and liver tumours are marginally and reversibly affected in the treated animal.

4.5 Antifertility activity

According to Reddy et al. (2014), a 10 mg/kg dosage of P. longum extract reduced testosterone, LDH, and intratesticular activity. It also affected the epididymal cells, which are where sperm mature. Additionally, it showed that piperine's histological action at 10 mg/kg seriously damaged spermatocytes, spermatids, and seminiferous tubules. The effects of P. longum extracts were investigated in female rats, according to Laksmi et al. (2004), who found that the crude extract was 100% effective and the hexane fraction was 86%, while the other fractions showed no impact.

4.6 Antimicrobial activity

The different solvent extracts of P. longum were tested against a variety of harmful bacteria and fungi, according to Abbas Ali (2007). While antifungal activity was not as strong, crude extracts showed mild to moderate antibacterial effects. Additionally, Saraf et al. (2014) found that the P. longum plant evaluated for antimicrobial activity and secondary metabolites. Extracts were evaluated against Klebsiella pneumoniae, Streptococcus pyogenes, and Staphylococcus aureus, three respiratory tract pathogens. The minimal inhibitory concentration of powder was evaluated. Zone of inhibition tests were performed on solvent fractions. Staphylococcus aureus is most vulnerable, whereas Klebsiella pneumoniae is most resistant.

4.7 Analgesic activity

According to Vedhanayaki et al. (2003), P. longum root, also known as Kandantippili, has historically been used to treat rheumatism, sleeplessness, palsy, and epilepsy due to its pain-relieving properties. Rat tail-flick and acetic-acid writhing methods were used to evaluate the root for opioid and NSAID analgesia; pentazocine and ibuprofen were used as references. At 400 and 800 mg/kg, it demonstrated significant NSAID effectiveness with a negligible opioid effect compared to pentazocine. This suggests that although P. longum root has very weak opioid analgesic effects, it has potent NSAID effects.

4.8 Enhancer of Drug Bioavailability

P. longum's function as a bioavailability enhancer is among its most prominent uses. Curcumin and several antibiotics are among the medications whose absorption and efficacy are greatly enhanced by piperine. P. longum showed enhanced activity with a range of distinct structural and therapeutic chemicals, according to Khajuria et al. (1998, 2002). Additionally, he proposes that piperine may affect membrane dynamics through its interactions with protein and lipid production. Piperine may improve intestinal absorption by affecting penetration across the epithelial barrier, change membrane properties, and boost protein synthesis

linked to cytoskeleton function. According to Atal et al. (2010), piperine improves nutritional absorption, which helps prevent malnutrition and chronic illnesses that might reduce resources. According to Vijayarani et al. (2020), chronic inflammation is linked to a number of illnesses, which calls for novel treatment approaches, especially for natural products like boswellic acids. Poor pharmacokinetics restrict their usage despite their effectiveness against inflammation. The impact of P. longum extract on the absorption of boswellic acid in rabbits was assessed in this study, and the results showed a considerable increase in bioavailability. Cytochrome P450 (CYP450) participation was proposed by computational modelling. The findings support the co-administration of boswellic acid and P. longum for improved therapeutic benefits in inflammatory conditions.

5. CLINICAL APPLICATIONS AND FUTURE DIRECTIONS

Although preliminary research and traditional applications demonstrate P. longum's medicinal potential, more clinical trials are required to verify its safety and effectiveness. Standardized extraction techniques, ideal doses, and possible drug interactions should be the main topics of research.

6. CONCLUSION

A rising amount of scientific research supports the medicinal potential of Piper longum, a plant with a long history of usage in traditional medicine. Its many pharmacological characteristics-such as anti-inflammatory, antioxidant, and anticancer effects as well as its capacity to improve medication bioavailability highlight its significance in contemporary medicine. Translating these findings into therapeutic practice will require more investigation.

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