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A 'Review On A Comprehensive Study On The Medicinal Properties And Active Constituents Of Piper Longum.

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Abstract

Ayurveda, the ancient science and philosophy of life, emphasizes the use of medicinal plants for maintaining health and treating diseases since early times. Piper longum Linn. (Pippali), commonly known as long pepper, is a highly valued medicinal herb in Ayurveda and traditional medicine systems. It possesses diverse therapeutic properties such as carminative, digestive, anti-inflammatory, antioxidant, analgesic, hepatoprotective, immunomodulatory, and antimicrobial actions. Pippali is used to treat respiratory disorders (asthma, cough, bronchitis), digestive issues (indigestion, loss of appetite), and liver ailments, and also acts as a bioavailability enhancer for various drugs.

The plant contains major phytoconstituents such as piperine, piperlongumine, piplartine, piperlonguminine, and various essential oils and alkaloids, which contribute to its pharmacological effects. This review highlights the botanical description, Ayurvedic properties (Rasa: Katu; Guna: Laghu, Snigdha; Virya: Ushna; Vipaka: Madhura), formulations, therapeutic uses, dosage, and pharmacological activities of Piper longum Linn. Additionally, pharmacognostical and preliminary phytochemical analyses of its fruit, including macroscopic and microscopic characteristics, physico-chemical constants, TLC, and HPTLC profiles, are discussed.

Kye point **-** Pippali,(piperine) ayurvedic medicine ,herbal preparation.

I. INTRODUCTION

Pippali (Piper longum Linn.), also known as long pepper, is an important herb in Ayurveda. It is commonly used in many Ayurvedic medicines and also as a spice in Indian cooking.Even though it is used often, ancient Ayurvedic texts warn against taking it in large amounts or for a long time.

According to recent studies, the powdered form of Pippali has not yet been fully tested for its toxic effects when taken in high doses.

Therefore, this study aims to find out if Pippali causes any harmful effects by testing its acute (short-term) and sub-chronic (medium-term) toxicity on albino rats.In Ayurveda, Pippali (long pepper) is known as a powerful and versatile herb. It has a warming nature that helps balance the Kapha dosha, one of the body's main energies in Ayurveda.

One of Pippali's special qualities is that it helps the body absorb other herbs and medicines better. Because of this, it is often used in Ayurvedic medicines to increase their effectiveness. It helps improve the absorption of nutrients, antioxidants, and other active compounds, making treatments more powerful.

Pippali is well known for helping with digestion. It improves appetite and reduces problems like bloating, gas, and indigestion. Ayurvedic doctors often add it to digestive tonics and herbal formulas for these benefits.

Besides digestion, Pippali is believed to have antioxidant, anti-inflammatory, and immune-boosting properties. It helps strengthen the immune system, supports respiratory health, and can reduce symptoms of coughs, colds, and asthma.

Pippali can be used in different forms — raw fruits, dried fruits, powders, or herbal mixtures. It is often combined with other herbs like ginger, black pepper, and long pepper to enhance its effects.

However, it's important to use Pippali carefully. Taking advice from a qualified Ayurvedic doctor is necessary to determine the right dose and duration, as overuse may cause side effect.

Botanical Description –

Habitat: It grows in warm regions of India — from the central Himalayas to Assam, the Khasi and Mikir hills, Bengal, and the evergreen forests of the Western Ghats (from Konkan to Travancore).

Habit: A slender, aromatic climbing plant with long-lasting woody roots.

Root: Thick, jointed, upright, and branched roots.

Stem: Many stems (0.6–0.9 m long), either growing upward or along the ground. They are thick, round, slightly hairy, and swollen at the joints.

Leaves: Heart-shaped, smooth, and hairless with entire edges.

Flowers: Small, unisexual flowers without petals, tightly packed on spikes. Male and female flowers grow on separate plants.

Fruit: Oval, yellowish-orange fruit embedded in a fleshy spike.

Uses of Piper longum (Pippali) in Ayurveda –

Piper longum, known as Pippali or Long Pepper, is an important Ayurvedic herb used in many formulations. Some of its traditional preparations are:

Trikatu – Made from Long Pepper, Black Pepper, and Ginger. Used for fever, stomach issues, asthma, cough, and as a digestion enhancer.

Vardhamanas Pippali Rasayana – Contains Piper longum, honey, and ghee. Treats bronchitis, asthma, piles, spleen problems, arthritis, and abdominal diseases.

Talisapatradi Churna – Made of Black Pepper, Long Pepper, and Ginger. Helps in respiratory distress, cold, cough, abdominal pain, constipation, and nose bleeding.

Pippalyadyasava – Combination of Black Pepper and Long Pepper. Used for indigestion, anemia, and abdominal problems.

Kanakasava – Includes Long Pepper, Mulethi, Ginger, and Vasaka. Helps open airways, relieves cough and asthma, reduces pain, and supports heart function.

Balacaturbhadrika – Contains Piper longum, Aconitum heterophyllum, and Pistacia integerrima. Useful for fever, diarrhea, cough, and asthma.

Shringyadi Churna – Contains Piper longum, Aconitum palmatum, and Pistacia integerrima. Treats asthma, diarrhea, cough, and fever.

Amritarishta – Made from Tinospora cordifolia (Giloy), Long Pepper, Ginger, Black Pepper, and other herbs. Used for typhoid, fever, anemia, jaundice, gout, poor appetite, and liver disorders. Boosts immunity and fights infections.

Guda-Pippalyadi Choorna – Contains Ginger, Long Pepper, and Jaggery. Treats insomnia.

Shiva Gutika – Includes Piper longum, Ginger, Cardamom, Cinnamon, and Honey. Improves digestion and treats cystic ovarian diseases.

Kaishore Guggulu – Mixture of herbs like Piper longum, Terminalia, Zingiber, and Tinospora. Relieves pain, purifies blood, and helps with diabetes, skin, and joint disorders.

Kumaryasava – Contains Aloe vera, Long Pepper, Ginger, and spices like clove and turmeric. Used for abdominal pain, epilepsy, digestion issues, and menstrual disorders.

Material and Methodology –

Pippali is mentioned in all the Nighantus (Ayurvedic dictionaries). These books describe the different names, actions on doshas, and properties of Pippali.

For this study, information was collected from the e-book “eNighantu” and other online sources.

The Nighantus referred to are:

1.Ashtang Nighantu

2.Bhavprakash Nighantu

3.Kaiyadev Nighantu

4.Dhanvantari Nighantu

5.Mawdanpal Nighantu

6.Raj Nighantu

7.Laghu Nighantu

8.Saraswati Nighantu

9.Shodhal Nighantu

10.Dravyaguna Sangraha

Taxonomical classification –

Kingdom - Plantae

Subkingdom - Tracheobionta (Vascular plants)

Superdivision - Spermatophyta (Seed plants)

Division - Magnoliophyta (Flowering plants)

Class - Magnoliopsida (Dicotyledons)

Subclass - Magnoliidae

Order - Piperales

Family - Piperaceae

Genus - Piper

Species - Piper longum

Different Varieties of Pippali –

*According to Sushruta and Vagbhata, there are four types of Pippali:

1.Pippali – Piper longum Linn.

2.Gaja Pippali – fruits of Piper chaba Hunters

3.Simhali

4.Vana Pippali

Material and methods of extraction -

Materials -

Long pepper was bought from a local spice market in Mumbai, India. It was dried in the sun and ground into a fine powder with pieces about 0.40 to 0.55 mm in size. The moisture content was measured at 5.23%. The chemicals used like Standard Piperine, Acetonitrile, Acetone, and Hexane were bought from Total Herb Solutions Pvt. Ltd, Mumbai and were of high-quality analytical grade. Pure water and acetonitrile used for extraction were also of analytical grade.

Apparatus -

Ultrasound assisted extraction was done using an ultrasound cleaning bath (Model 6.5I200 H, Dakshin, India) with internal dimensions of about 230 x 150 x 150 mm and a temperature control system. The bath had a power output of 200 W and worked at frequencies of 25 kHz and 40 kHz. It had heater control, digital timer, and cooling water circulation. The power to the ultrasound was controlled by an auto transformer.

Ultrasound Assisted Extraction -

The extraction was done in a glass container with a flat bottom, 13 cm long and 5 cm in diameter. It was placed in the ultrasound bath. The distance between the glass vessel bottom and the ultrasound transducers was kept at 2.5 cm and kept constant during the experiments. This setup follows earlier research by Kulkarni and Rathod (2013) using ultrasound to extract compounds from Piper longum powder.5 grams of Piper longum powder was mixed with 50 ml of ethanol in the glass vessel and placed in the ultrasound bath.

The mixture was exposed to ultrasound for 30 minutes. Samples were taken every 3 minutes in small amounts (0.1 ml) and diluted for analysis using HPLC to measure the extraction of piperine. The study examined how different conditions affect the yield of piperine.

Types of extraction - piperine is a strong-smelling natural compound found in plants of the Piper genus, like P. nigrum and P. longum. It is extracted from the oily parts of these plants. Different extraction methods like maceration or Soxhlet with organic solvents are used to get piperine, which appears as a dark brown oily substance. It can also be purified further using techniques like column chromatography or supercritical fluid extraction. These methods vary depending on the amount of piperine needed and what it will be used for verius preprations.

Soxhlet Extraction:

A Soxhlet apparatus was used to extract piperine. It has a flask in an oil bath, a thimble holder, and a condenser. About 5 g of Piper longum powder was put in a cellulose filter in the thimble, then filled with ethanol solvent in a flask below. Piperine dissolves in the solvent as it cycles between the flask and the thimble through siphoning. About 150 mL of solvent was used at 80°C for several cycles. Extracted samples were collected every 2 hours to check piperine content.

Batch Solvent Extraction:

To compare, batch extraction was done by mixing 5 g of Piper longum powder with 50 mL ethanol in a glass reactor, heated at 40°C and stirred at 600 rpm for 8 hours. Samples were taken every hour to analyze piperine.

Analytical Method:

Piperine was measured using High Performance Liquid Chromatography (HPLC). The instrument used specific columns and detectors to separate and detect piperine. The mobile phase (solvent system) flowed through the column, and the piperine appeared at a retention time of 7.2 minutes.

Chemical composition –

Sr. No.	Constituent Type	Example	Plant part
1	Alkaloids	Piperlongumine, Piperlonguminine	-
2	Hydrocarbons	n-Hexadecane, n-Heptadecane, n-Octadecane, n-Nonadecane, n-Eicosane, n-Heneicosane	-
3	Terpenes	Thujene, Terpinolene, Zingiberene, p-Cymene	-
4	Other Compounds	p-Methoxy acetophenone, traces of Dihydrocavicol, Phenyl ethyl alcohol	-
5	Sesquiterpenes	Piperine, Piplaritin, Triacontane, Dihydrostigmasterol	-
6	Unidentified Compounds	Steroid, Reducing sugar, Glycosides,	Root

		Sesamin, Methyl 3,4,5-trimethoxycinnamate	
7.	Major alkaloids	Piperine, Sesamin	Stem & Fruit
8	Sesquiterpene Hydrocarbons	Caryophyllene, Sesquiterpene alcohol, Carbonyl compound (essential oil)	-
9	Diamide	N-isobutyl-deca-trans-2-trans-4-dienamide	-
10	Lignan	¤ D-sesamin	-
11	Piperidine Alkaloids	Pipermonaline, Piperundecalidine	Fruit

Isolation and Extraction of Piperine from Piper Plants-

Piperine can be taken from the oil part of Piper nigrum or Piper longum. The dried fruits are soaked in a chemical called dichloromethane for 12 hours at room temperature while stirring. The mixture is then filtered and concentrated. The leftovers are purified using an alumina column. Piperine can also be made by crystallizing it from ethanol. This is useful for food or medicine.Usually, piperine is taken directly from crude residue using alcohol extraction, filtration, and crystallization.

Properties of Piperine –
Structure -

Chemical names: 1- piperoyl piperidine

1- Molecular weight: 285.33 gm/mol

2- Composition percentage:
Carbon : 71.55%
Hydrogen (H): 6.71%
Nitrogen (N): 4.91%
Oxygen (O): 16.82%

Health benefits of piperine –

1. Anticancer Activity

Mechanisms:

Inhibits growth of cancer cells and promotes their death (apoptosis).
Increases tumor-suppressing proteins (Bax, p53) and decreases cancer-promoting proteins (Bcl-xl, cyclin A).
Reduces lipid peroxidation (cell membrane damage).
Suppresses proteins linked to cancer spread — like VEGF (angiogenesis factor), MMP-2, and MMP-9 (invasion enzymes).
Downregulates E-cadherin and β-catenin pathway to prevent cancer cell adhesion and growth.
Reduces secretion of IL-8 and inhibits Helicobacter pylori activity (linked with stomach cancer).

Health Benefits:

Reduces tumor growth, slows cancer progression.
Enhances survival time in experimental models.
Works synergistically with chemotherapy drugs like docetaxel (improves efficacy and lowers toxicity).
Potentially beneficial against multiple cancers (breast, colon, liver, gastric, skin).

2. Diabetes Mellitus

Mechanisms:
Lowers blood glucose levels and increases insulin secretion.
Improves glucose tolerance and decreases insulin resistance.
Reduces liver enzyme levels (AST, ALT, ALP) — markers of liver stress.
Controls inflammation by reducing IL-1β, TNF-α, NF-κB, and NLRP3 activity.
Increases antioxidant activity and reduces oxidative stress.

Health Benefits:

Protects against diabetic complications (kidney, liver, and heart damage).
Helps maintain normal blood sugar and lipid levels.
Improves insulin function and body metabolism.

3. Obesity

Mechanisms:

Reduces body weight, body fat, and lipid levels.
Improves glucose and lipid metabolism.
Decreases oxidative stress and inflammation in fat tissues.
Regulates genes involved in fat formation (SREBP-1c, C/EBPβ, PPARγ).
Lowers activity of lipid-forming enzymes like HMG-CoA reductase and FAS.

Health Benefits:

Helps in weight management and prevents fat accumulation.
Improves liver and heart health.
Enhances energy metabolism and decreases risk of metabolic syndrome.

4. Cardiovascular Diseases

Mechanisms:
Protects heart tissues from oxidative damage.
Reduces mitochondrial swelling and prevents DNA damage.
Improves cholesterol metabolism: increases HDL (good cholesterol) and reduces LDL (bad cholesterol).
Prevents abnormal heart rhythm (cardiac action potential).
Decreases production of reactive oxygen species (ROS) and improves enzyme activities (LCAT, CYP7A1).

Health Benefits:

Reduces risk of heart attack, atherosclerosis, and oxidative stress.
Improves heart function and lipid profile.(9)

5. Anti-Aging

Mechanisms:
Reduces age-related oxidative stress and inflammation.
Protects brain cells and improves coordination and memory.
Balances IL-1β and Bcl-2/Bax ratio (protects neurons).
Reduces mitochondrial damage and improves energy metabolism.

Health Benefits:
Slows down aging effects on brain and body.
Improves learning, movement, and cognitive abilities.

6. Antiallergic Effect

Mechanisms:

Decreases release of histamine and β-hexosaminidase
Suppresses cytokines (IL-4, IL-6, IL-13, TNF-α).
Inhibits IgE-mediated allergic responses and reduces inflammatory cell infiltration.
Reduces swelling and allergic skin reactions.

Health Benefits:

Relieves symptoms of allergic reactions (edema, itching, inflammation).
Supports immune balance and reduces hypersensitivity.

7. Immune Dysfunction

Mechanisms:
Prevents cell death (apoptosis) in immune cells.
Protects mitochondria and DNA in immune tissues.
Reduces oxidative stress and restores normal cytokine levels after toxin exposure.

Health Benefits:

Strengthens immune defense.
Protects body from toxin-induced immune suppression.

8. Anti-Inflammatory

Mechanisms:
Suppresses inflammatory cytokines (IL-1β, IL-6, TNF-α).
Reduces oxidative stress, nitrite, and lipid peroxidation.
Increases IL-10 (anti-inflammatory cytokine).
Inhibits NF-κB, MAPKs, and other inflammation-related pathways.

Health Benefits:

Reduces swelling, pain, and inflammation in tissues.
Useful in managing arthritis and chronic inflammatory diseases.

9. Hepatic (Liver) Disorders

Mechanisms:

Lowers liver enzymes (AST, ALT, ALP, total protein) indicating protection.
Reduces lipid peroxidation and increases antioxidant enzyme activity.
Improves liver fat metabolism by enhancing CPT1 gene expression.
Decreases insulin receptor substrate (IRS-1) phosphorylation to improve insulin sensitivity.

Health Benefits:

Protects liver against toxins and fatty liver disease.
Improves liver function and metabolism.

Conclusion –

Piper longum (Pippali) is a significant medicinal plant in Ayurveda and traditional medicine, known for its wide range of therapeutic applications. Its diverse phytochemical constituents, such as piperine, piperlongumine, and piplartine, contribute to its anti-inflammatory, antioxidant, antimicrobial, hepatoprotective, and immunomodulatory activities. The plant is also valued for its ability to enhance drug bioavailability and support the treatment of respiratory, digestive, and liver disorders.

The pharmacognostical, phytochemical, and pharmacological studies reviewed confirm that Piper longum possesses both preventive and curative health benefits. These findings validate its traditional uses and provide a strong foundation for modern drug development and clinical research. Future investigations focusing on the isolation of bioactive compounds, mechanisms of action, and standardization of formulations will further establish Piper longum as a valuable herbal medicine in both traditional and modern healthcare systems.

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