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Phytochemical and Pharmacological Properties of Piper Longum

Gitesh Kumar, Akshay Kumar

Abhilashi University

ABSTRACT

Piper longum L. is a plant that belongs to the Piperaceae family and has been used historically in food and traditional medicine in South Asian countries. Characterised by its spicy fruits, it can be used as a spice in cooking. It has been used historically in traditional herbal formulations using both the fruit and root. Research is being carried out due to its chemical diversity and biological activity shown in extracts and constituents within the plant. [1, 7, 10, 29]

Studies have shown that P. longum contains many different phytochemical groups including alkaloids and amides, lignans, flavonoids, volatile compounds and sterols. Piperine is one of the best known spicy compounds within this plant. Piperlongumine has been highlighted in experimental research. There has been research carried out to study the antioxidant, anti-inflammatory, antimicrobial and analgesic properties of the plant. When studying isolated compounds, lab research and animal models it is important to note that this does not mean the whole plant would show efficacy or safety to treat disease in humans. [1-3, 6, 8-10, 14, 25, 27, 28]

This review will outline some information regarding the plant's classification, common names, morphology, and phytochemical groups reported to be present. It will also highlight where there are gaps in the evidence. Each claim made regarding the individual chemicals needs to be verified. It is important to note that just because a compound was found to have some effect in an experiment it does not mean that the whole plant would show this effect. To make detailed recommendations for the cultivation of this plant it would be necessary to consult a specialist source regarding agriculture.

Keywords: Piper longum, Long Pepper, Pippali, Piperine, Phytochemistry, Medicinal Plant, Pharmacological Research.

1. INTRODUCTION

Piper longum L. is a perennial plant that belongs to the Piperaceae family. It is commonly known as Long Pepper or Pippali and is prized for its spicy and aromatic properties. It has been used historically in food in South Asian countries as a spice due to its dried fruiting spines. It has also been used in traditional medicine systems. This means that it has historical significance but does not guarantee clinical efficacy. [1, 7, 10, 29]

This plant can be identified by its compact fruiting spines. Whilst it is in the same family as Black Pepper (Piper nigrum) it is not the same plant and should not be considered as interchangeable. Correct identification is very important when researching medicinal plants in order to know what species, part of the plant, growing conditions and processing methods were used. [11, 12, 36]

Research has been carried out into this plant to see what natural compounds it contains. Piperine is commonly discussed for its spicy properties and absorption/metabolism properties. Other compounds have been looked at in lab research including piperlongumine and volatile compounds. Different compounds have shown different effects depending on what compound, extract, dosage and what model was used. Therefore, care should be taken with any claims made for this plant. [2, 6, 8-10, 12, 25]

This project will provide some information on this plant and some highlights from the literature. It does not guarantee that this plant is an proven treatment for any specific disease. As the evidence has been taken from pre-clinical research this should be noted. Additionally, this section will highlight that it is important to ensure sources have been verified before publishing.

1.1 Project Overview

This project is a narrative literature review using the references provided. It will provide information on important topics relating to this plant's botanical identity, chemical constituents and pharmacological research. It is not a systematic review so no detailed search strategies, screening, bias analysis or meta-analysis has been carried out. If aiming to submit this as a systematic/scoping review please ensure that the search strategy and selection criteria has been added.

2. TAXONOMICAL CLASSIFICATION

Correct identification is important when providing information on this plant. The accepted name and classification of this plant can be found on the Plants of the World Online database provided by the Royal Botanic Gardens, Kew. [35]

Taxonomy Classification	
Kingdom	Plantae
Order	Piperales
Family	Piperaceae
Genus	Piper
Species	Piper longum L.

This is a basic taxonomy classification to keep the project short. Botanical databases may show more classifications and the taxonomy may be updated. Ensure that the scientific name is always written in the same format throughout your manuscript. The Genus name should be capitalised, species name lowercase and the scientist that described the plant should be included.

If this plant is being used in experimental research it is best to ensure that it has been correctly identified. This can be done by ensuring that you have a documented specimen/herb voucher. This means that you can easily identify what part of the plant was used in future readers. This reduces the risk of confusion with similar species. [35] Royal Botanic Gardens, Kew. Plants of the World Online.

3. SYNONYMS AND COMMON NAMES

This plant has many different names in different languages, regions and traditional medicine systems. Common names include Long Pepper, Indian Long Pepper, and Pippali/Pipli. Other names include pippalim, magadhi, kana and lendi pepper. Common names can vary depending on the location, therefore it is best to use the scientific name to clearly identify which species you are talking about. [29, 36]

The plant can also have different names for different parts. In Ayurvedic medicine the fruit is commonly known as pippali whilst the root may be known as pippalimoola. Whilst this can be helpful when discussing traditional formulations it is important to state which part of the plant was used in your research. This can help as different parts of the plant can have different chemical compositions. [36]

Older literature will contain the name Piper longum Linn. The abbreviation Piper longum L. is a standard format. Older papers may use old spellings and naming conventions. These should be included in the titles of the references. In the main text just one format of the scientific name should be used.

When gathering literature it is important to note what name has been used, what part of the plant was used, and any information about how it has been authenticated. This makes it easy to identify if the research has been carried out on the whole plant or a specific extract/compound.

4. BOTANICAL DESCRIPTION

Piper longum is a perennial herb or climber. Leaves can vary in shape and size along the stem. Leaves at the bottom of the plant are often larger and heart shaped, whilst leaves higher on the plant can be smaller and different shapes. This plant should not be identified by one feature alone. [36]

The flowers grow in spines. Male and female flowers have been reported to grow on separate spines. The fruit forms a compact, cylindrical cluster from the small fruits. The mature spines are commonly green/dark green and show the characteristic spicy taste. The dried fruiting spines are most commonly recognised in cooking. [36]

If this plant is being used in a scientific project it is important to give a botanical description based on a reliable flora or based on an authenticated specimen. Photos can be useful but should have a caption stating what plant, part of the plant, source and date (if known). Do not include images copied from websites unless you ensure that you have permission and know how to cite them.

This description has been kept general. Specific measurements may vary and should be taken from a specific botanical source or well described specimen. Ensure the botanical reference in the bibliography has been verified before publishing. [36]



Figure 1. Piper longum plant showing leaves and fruiting spines.

5. PHYTOCHEMICAL CONSTITUENTS

Research has shown that this plant contains many different phytochemical groups. Alkaloids and amides, lignans, flavonoids, volatile compounds from essential oils and sterols have been reported. This can vary depending on the part of the plant, geographical source, maturity, storage, extraction method and analytical technique used. [1, 5, 10, 12, 29]

It is important to note that just because a compound has been reported in the species, found in an extract or tested after isolation it does not mean it will show the same effects in the whole plant. The concentration may not be the same.

5.1 Alkaloids & Amides

Piperine is one of the most well known spicy compounds within the Piper genus. It has been discussed extensively in the literature regarding chemistry, pharmacology and pharmacokinetics. Research has been carried out to look at how it may influence the metabolism and bioavailability of certain substances. This can be important to know but should not be used as a reason to change prescribed medications or the dosage without consulting a qualified healthcare professional. [2, 4, 6]

Piperlongumine (piplartine) has been looked at in experimental research. This includes looking at cellular stress responses. Other amides include chavicine, piperettine, piperlonguminine and guineensine. The properties of these compounds vary and cannot be assumed that the whole plant would show the same effect. [8-10, 12]

5.2 Lignans

Sesamin and asarinin have been discussed in the literature provided. Some studies looked at antioxidant and inflammation properties of these compounds. However many studies looked at isolated compounds or other botanical sources. This means we cannot assume they would show the same effect in P. longum or when used in normal dietary conditions. Please check the original articles to ensure you know exactly what source and model was used. [15-18]

Flavonoids

Quercetin, catechin and kaempferol have been discussed in the review. These compounds have been widely researched in plants. However there is not one validated quantitative profile for all samples of P. longum provided by the reference list. Therefore they should be described as compounds discussed or reported.



Figure 2. Dried fruiting spines of Long Pepper.

6. PHYTOCHEMICAL CONSTITUENTS (CONTINUED)

6.1 Essential Oils & Volatile Compounds

Volatile compounds such as β-caryophyllene, limonene, sabinene, pinene and linalool have been discussed in relation to essential oil research. One study looked specifically at the essential oil of the fruit. The identity and quantity of volatile compounds can vary depending on the sample, extraction and analysis methods. This means that you cannot guarantee that all batches will show the same findings. [25]

6.2 Sterols, Tannins & Other Compounds

Other compounds mentioned in the literature include β-sitosterol, stigmasterol, tannins and many amides such as retrofractamides and longamide. Evidence for individual compounds varies. Some may have been identified in chemical research but may have only been tested for any biological effects in a few experimental models. Please look at primary research papers. [1, 12, 29]

6.3 Interpreting Phytochemical Evidence

A list of compounds is most useful if it includes what plant and part of the plant was used, what solvent was used during extraction, what analytical technique was used and how confident they are with their identification. Without this it can be hard to compare results between studies. It is important to not assume that all compounds within a group will show the same activity. Chemical identification, biological testing and clinical evaluation are all answering different questions and therefore should be reported separately.

This project provides a summary of the compounds discussed in the references provided. It does not provide a complete list of chemicals or validated concentrations. If a table has been created to show individual compounds please ensure it has been verified against the relevant primary articles before submitting to a journal.

7. REPORTED PHARMACOLOGICAL PROPERTIES

Research has been carried out into extracts and compounds within this plant. The following sections will discuss some of the areas that have been looked at in the literature provided. These areas should not be assumed to prove that long pepper can prevent or treat any disease in humans. The design of the study, dosage, extract and model will affect how the findings should be interpreted. [1, 3, 10, 29]

7.1 Anti-inflammatory

Some studies have shown anti-inflammatory or anti-arthritic effects in experimental models. Other research has looked at piperine in inflammatory models. This can be useful for hypothesis generation but cannot be assumed to show clinical benefits in humans. [27, 28]

7.2 Antioxidant

Compounds have been looked at for their effects on oxidative stress and antioxidant properties. Care should be taken when interpreting this due to the differences between chemical antioxidant testing, cellular testing, animal models and clinical outcomes in humans. A positive result in one area does not mean there will be a health benefit from consuming the plant. [15, 17-20]

7.3 Antimicrobial

Extracts and essential oils have been shown to have activity against certain microorganisms in laboratory conditions. This depends on the organism, testing method, concentration and preparation. This cannot be assumed to show that the product will be effective against an infection. Laboratory findings cannot be used instead of appropriate clinical evidence. [25]

7.4 Analgesic & Antipyretic

Some studies have looked at the effects on pain and fever. This includes looking at fruit extracts and bioactive amides. Please ensure you check the details of the model and preparation used in each original article to make more specific claims. [14, 30]

7.5 Antitumour & Cytotoxic

Piperlongumine and piperine have been looked at in experimental cancer research. This can provide some information on biological pathways or to support further lab research. This does not show that P. longum or preparations will be cancer treatments. If mentioning cancer please ensure you are very specific with your statements to indicate that this is pre-clinical research and not showing outcomes in human patients. [3, 8-10]

8. REPORTED PHARMACOLOGICAL PROPERTIES (CONTINUED)

8.1 Antidiabetic

One study looked at the effects of an aqueous root extract in rats with experimentally induced diabetes. This can provide some initial information but cannot be assumed to show efficacy or safety in humans. Please check the original paper to ensure you know what part of the plant was used, how it was extracted, what dosage was used, what outcomes were measured and what limitations there were. [37]

8.2 Bioavailability & Drug Metabolism

Piperine has been looked at for its effects on the metabolism and bioavailability of certain medications and compounds. This is an important area to look at due to the possible interactions. This should be taken into consideration but should not be used as a reason to take herbal products with medications or alter your medication without professional advise. [2, 6]

8.3 Overall Assessment of Evidence

There is varying evidence for each area of research. Do not assume that in vitro, animal, traditional or controlled human studies all show the same level of evidence. A balanced review should be created to show what type of evidence is supporting each statement. Do not make generalised statements as there is only preliminary data. There is no clinically validated indication that P. longum as a whole plant has therapeutic effects based on the references provided.

Evidence would be strengthened by using well characterised plant material, consistent extraction methods, appropriate controls, clear reporting and independent replication. If considering using this plant in a clinical setting then safety, dosage, interactions and human outcomes should be assessed using appropriate clinical research and regulation.

9. CULTIVATION & HARVESTING

Cultivation and harvesting can affect the quality of the plant. However the review provided does not give much information on cultivation and therefore there is not enough information to make specific recommendations for P. longum. No specific information has been provided regarding soil requirements, propagation methods, spacing, watering schedule, maturity for harvesting and drying temperatures.

A full section on cultivation should be based on a reliable agricultural manual or research paper specific to this plant. At a minimum the source should provide information on what growing conditions the plant prefers, propagation, planting, routine crop management, pest and disease problems, signs of maturity for harvesting and drying/storage.

Harvesting and storage should also be discussed. The part of the plant that was harvested should be clearly stated. The harvesting process should be clearly explained so another researcher can understand how the material was prepared. If intending to carry out any chemical analysis it is important that the samples can be tracked back and stored consistently to reduce unnecessary variation.

Add an appropriate reference to cultivation and ensure that all practical recommendations have been verified against this source. Do not add any extra agronomic information that has not been verified.



Figure 3. A selection of fresh and dried long pepper throughout post-harvesting.

10. LIMITATIONS AND AREAS TO INVESTIGATE

This project was based on literature found and has not systematically reviewed all evidence. The references given in the source document include a variety of different literature such as reviews, experimental and botanical. There are also some missing pieces of information and some references within reviews do not support all statements made. This means this manuscript should be considered as a draft until all references have been individually checked.

To improve this project for a future publication there should be verification of the references given. This would include checking authors, title of article, year, volume, issue, pages and DOI (if available) from the publisher or a reliable academic database. Any statements regarding specific compounds should be backed up with primary literature relating to chemical or pharmacological properties. If the targeted journal requires it, a clear description should be included on how the review was carried out. This could include databases used, keywords, time frame and inclusion criteria.

Evidence should be categorised depending on what type of study was carried out. The traditional use can relate to cultural/historical uses. In-vitro can show potential biological effects. Animal studies can show effects in an animal model. Clinical studies look at the outcome in humans. All of these are very different and cannot be swapped around. Language should not be used to imply that lab findings prove that the treatment will work in humans.

Authentication of the plant and recording of samples is fundamental when working with plants. In future studies a voucher specimen, clearly labelled plant parts, repeatable extraction methods, chemical profiling and transparent limitations should be included. Any claims regarding clinical properties should have suitable evidence from humans. Safety should be carefully considered including any potential interactions.

11. CONCLUSION

Piper longum L. commonly known as long pepper or pippali is an important plant used in cooking and traditional medicine belonging to the Piperaceae family. The literature found shows that there are many different types of compounds found in this species. These include piperine and related amides, lignans, flavonoids, volatiles and sterols. This has lead to research on the biological activities of this plant. These include anti-inflammatory, antioxidant and antimicrobial properties. [1, 3, 10, 12, 29]

The findings should be considered depending on the type of evidence. Any results using isolated compounds or experimental models cannot be assumed to apply to the whole plant or prove it will have a benefit in humans. The potential effects on drug metabolism means that safety and interactions should be looked into. [2, 6]

A thorough scientific report on P. longum needs to include correct authentication, clear descriptions of the plant material, verified references. A clear distinction between traditional use, pre-clinical findings and clinical outcomes. Before submitting this project for publication all references should be checked against the original. The cultivation section should be backed up with a specific agricultural source. Further thorough research may help to understand more about the plant chemistry, biological activities and potential uses.

12. REFERENCES

The following list is based on the references supplied with the source manuscript. Some entries use abbreviated author lists or may require bibliographic correction. Verify each item against the original publication before submission.

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