



A Review on Pharmacological, Nutraceutical, and Pharmacognostical Study of *Piper nigrum*

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ABSTRACT

Black pepper, the 'King of spices' (*Piper nigrum* L.), is a widely used spice, it has a pungent odour. Plant sources were used in time-honored systems of medicine and daily regular uses, such as in food preparation and cosmetic purposes. This is outstanding to their infinite pharmacological activity with few side effects. Among the variety of species of the Piperaceae family, black pepper is one of the trendiest due to its principle pharmacological component, piperine. Which is an alkaloid that has a wide range of pharmacological activities like antioxidant, anti-obesity, antitumor, antipyretic, anticonvulsant, anti-thyroid, antifungal, antibacterial, insecticidal, hepatoprotective, anti-asthmatic, larvicidal, antihypertensive, anti-inflammatory, antidiabetic, antidiarrheal, bio-availability enhancer, immunomodulator, antiepileptic, antifertility, GI stimulant, lipid metabolism accelerator, anticancer, CNS stimulant, diuretic, aphrodisiac, blood purifier, and antiplatelet activities, etc. Due to some spiritual value of black pepper, it's being admired from ancient times to modern generation. This review article is designed to provide recent advancement of pharmacognosy, pharmacological activities, cell-based studies, other traditional use and role of Nutraceuticals.

Keywords: Anti-inflammatory, piperine, extraction, Varieties of *P.Nigrum*.

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INTRODUCTION

Plants have a natural capacity to sustain fine health science in ancient times. Now, the interest in natural products as active agents has deeply enhanced due to its chemical constituent¹. Spices are mostly high in bioactive chemical constituents and which have been used by a number of cultures for lots of centuries as a food seasoning, preservatives, insecticidal, coloring agents, and natural flavoring^{2,3}. Several spices are used to expand shelf-life of food, avoid food spoilage and food-borne diseases, however, some spices are used in the food production industry and also many spices are used to inhibit infectious diseases and eradicate pathogens, particularly in traditional medicine⁴. The antibacterial efficacy of some spices and seasonings have been proved scientifically, as an example of these spices; black seed (*Nigella sativa*),⁵ garlic bulb (*Allium sativum*),⁶ onion (*Allium cepa*),⁷ thyme (*Thymus vulgaris*) and clove (*Syzygium aromaticum*),⁸ cinnamon bark (*Cinnamomum Verum*),⁹ oregano (*Origanum vulgare*),¹⁰ cumin (*Cuminum cyminum*)¹¹ and many more. According to fresh global awareness of natural products, medicinal plants, and conventional medicine, studies on spices should be re-energized in order to innovate new natural drugs.

Encouraging this is the fact that up to 80% of the world populations are still relying on medicinal plants and natural products in their primary health-care needs¹². The current brief review aimed to draw attention to the medicinal significance of black pepper fruits and its usefulness as much pharmacological activity.



It is one of the world most general kitchen spices and well recognized for its pungent chemical constituent piperine (1-peperoyl piperidine) discovered in 1819 by Hans Christian, which has diverse pharmacological activities¹³⁻¹⁴.

PHARMACOGNOSY OF THE *PIPER NIGRUM*

Botanical description of Black pepper

The genus of black pepper is *Piper* L. (family Piperaceae) consists of many varieties of species, spread mainly in tropical regions of the world¹⁵. *Piper nigrum* L. (black pepper) is the most well-known species of this genus, it is known as the "king of spices" due to its pungent principle piperine and the recognition in use for flavoring food all throughout the world¹⁶. On the other hand, *P. nigrum* has been used for medicinal purposes in many parts of the world since ancient times. *P. nigrum* is a woody climbing



vine growing to 9 m (30 ft) or more in length. The stem is grayish 1.2 cm (0.5 in) diameter. Many rootlets grow from enlarged stem nodes. Leaves dark green above and pale green under, glossy, ovate, and acutely tipped and range in size from 13–25cm (5–10 in) in length. Elongated, slender spikes or catkins (1.6–2cm in length) bear minute, white flowers. The flower spikes, each producing from 50–60 single-seeded dark red berries, approximately 5 millimeters (0.20 in) in diameter, always become visible on stems reverse the leaves¹⁷. Various parts of the plant are used for medicinal purposes, however, the part commonly used as the spice black pepper is the cooked and dried unripe berry¹⁸, so, we focused only on the use of this plant part.

Taxonomical Classification of *Piper nigrum*:

Kingdom	:	Plantae
Sub-kingdom	:	Tracheobionta
Super-division	:	Supermatophyta
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Subclass	:	Magnoliidae
Order	:	Piperales
Family	:	Piperaceae
Genus	:	<i>Piper</i> L.
Species	:	<i>P. nigrum</i> L.

Vernacular names

Arabic	:	Filil aswad, babary
Bengal	:	Golmorich, Kolukung
Bombay	:	Kalamiri, Miri
Ceylon	:	Molavu
Chinese	:	Fou Tsiao, Hu Chiao
Deccan	:	Choca, Kali mirchingai
English	:	Black pepper, pepper
German	:	Pfeffer
Greek	:	Peperi
Gujrati	:	Kalmari, Kalomirich
Hindi	:	Habush, Kali mirch
Italian	:	Pepe, pepe nero
Kashmir	:	Martz
Konkani	:	Miriam
Malayalam	:	Kolakam, Maricham
Marathi	:	Kalimirch
Punjab	:	Golmirch
Russian	:	Peretz

Sanskrit	:	Dharmapattana, Katuka
Spanish	:	Pimienta negra
Tamil	:	Aguttam, Arisu, Kari
Telugu	:	Marichamu, Miremu
Urdu	:	Kalimirch

Distribution

The black pepper plant distributed as branch, climb perennial shrub, mostly found cultivated in the hot and moist parts of India, Ceylon, and other tropical countries. Black pepper is one of the most cultivated crops in India and has probably originated in the hills of Southern-Western India¹⁹. It is generally originate in Southern India & cultivated in Kerala & Tamil Nadu and also originated in Singapore, Acheen and Lampong districts of Sumatra, Sri Lanka, France, Indonesia, Thailand, South America, and West Indies²⁰. It is indigenous to Malabar Travancore coasts, i.e. western coast of India²¹. Black pepper has been found throughout India in evergreen forests up to 1500 m²².

Varieties of *P. Nigrum*²³⁻²⁴

Mostly 600 varieties of pepper (genus *Piper*), but few are used as spice, frequently distinguished only by the degree of maturation and the type of processing. Common pepper on the market is the fruit of *P. nigrum*, consisting of small spherical green berries that reach a bright red when fully ripe. Depending on the period of collection and processing undergone, we can distinguish the following types of pepper.

1. Black pepper: It is produced from the seed of the pepper is still not too old then dried, so it changed the color to black and wrinkled. Marketing can be shaped grains, can also in fine form. This pepper is also used as a spice in cooking, such as soups, beef steak, and stir-stir.

2. White pepper: It is produced from the seeds of the pepper that is old then peeled, resulting in white color. This pepper used in rough shape, those that are sold in powder form. In the use of typically mixed in the seasoning. It has a distinctive flavor and aroma.

3. Green pepper: It is pepper that are picked and harvested when it was not too old and still green, so the sales Looks like he still had fresh. To maintain freshness he mixed with seasoning solution. Delicious for chicken dishes and sea food.

4. Red pepper: No red pigment in the skin is then peppercorns make this kind of pepper called red pepper. The taste of red pepper is different from the others. It has no less spicy and sweeter taste in this type of pepper. This pepper is proper to be used as a spice in seafood processing. Marketing is in the form of fresh and dried.



Pharmacognostical Characteristics

Black pepper (*Piper nigrum*) is flower timbered permanent climbing plants that concerned to Piperaceae family unit. Pepper plants effortlessly raise in the dimness at the bottom of trees, poles up to the greatest height of 13 ft. or 4 meters & roots may come out from leaf nodes if plant touch to the land. The plants have a heart outline as same as the leaves. The length of fine spikes moves up to 07-15 cm. The fruits are small (3 to 4 mm in diameter) called a drupe and the dried out unripe fruits of *Piper nigrum* are called a peppercorn. The fully mature fruits are pale red in colour and approx 05 mm in diameter. A black pepper fruit contains a only one seed. The plants has fruits from 04th or 05th year, and carry on to bear fruits up to 07 years. A single shoot contains 20-30 spikes of fruits. The gathered spikes are air dried to take apart the peppercorns from the spikes. The clean harvested undeveloped green fruits may freeze-dry to gather green pepper. The red covering of the ripen fruits is detached and the rough seeds are air dried to compose white pepper²⁵.

Chemical constituents

Black pepper contains moisture 13.2%; protein 11.5%; fat 6.8%; fiber 14.9%; carbohydrates 49.2%; mineral matter 4.4%; calcium 460mg/100 g; phosphorus 198mg/100 g; phytin phosphorus 115mg/100 g; Iron 16.8mg/100 g. Vitamin A value 1,800 I.U/100 g. The occurrence of oxalic acid (00.4-3.4%) has been reported. Starch is the predominant constituent of black pepper; it accounts 34.1% in it. The alkaloid piperine (C17 H19 O3 N, m.p.129-30) is considered to be the major constituent responsible for the bitter taste of black pepper. The chemical piperine, 1-piperoylpiperidine, is the major bioactive component present in both black and white peppers and individually has numerous reported physiological and drug-like actions similar to those reported for black pepper. Other pungent alkaloids, occurring in pepper in smaller quantity, are chavicine, piperidine, and piperettine. Oil of the pepper is an nearly colorless to slightly greenish liquid with a characteristic odor of pepper and also of phellandrene²⁶.

Pharmacological studies

Various studies have been conducted and proved different pharmacological actions of *P. nigrum*. Some among them are *in vivo* and *in vitro* as well animal studies. Some pharmacological studies of *P. nigrum* are listed below:

Alteration of digestive tract function: Black pepper extract enhanced stomach secretions and elevates the quickness of movement of food through the digestive tract. Some effects of black pepper are mainly due to piperine activating certain drug receptors. Black pepper also may modify the bioavailability of few food components and drugs, moderately by changing the body's systems controlling the metabolism and absorption of dietary constituents and drugs²⁷. This effect of black pepper has been found to develop the bioavailability of a number of agents, while the clinical consequences may not essentially be valuable.

Metabolism and obesity: Piperine has been revealed in animal studies to boost the body's outflow of energy. it seems that, piperine does this by enhancing the production of hormone-like chemicals that control energy balance. This may have vital implications for human body weight regulation and obesity, even if, to date, there is little facts to support such a benefit in humans²⁸.

Nervous system benefits: In human study, inhalation of black pepper oil components improved the swallowing reflex in stroke patients, apparently by activating specific regions of the brain²⁹. A novel effect of inhalation of black pepper extract was the stimulation of respiratory tract sensations that apparently alleviated smoking withdrawal symptoms³⁰. Preliminary, Inconclusive Animal studies suggest that piperine may have an antidepressant-like action, but the amounts that are beneficial are poorly defined³¹⁻³⁶.

Treatment of skin disorders: A number of cell culture studies using pigment-producing cells from the skin showed that black pepper extracts stirred cell multiplication and function. It has been recommended that piperine may be valuable in treating the depigmentary skin disorder vitiligo³⁷. Also, black pepper extract and piperine exhibited antiandrogenic activity and stimulation of hair regrowth in one animal study³⁸, However, there is a lack of evidence for such benefit in human studies.

Antioxidant activity

Antioxidants in pepper can prevent or repair the damage caused by the free radicals and thus help prevent cancer, cardiovascular diseases, and liver problems. Free radicals are the by-products of cellular metabolism that attack healthy cells and cause their DNA to mutate into cancerous cells. Antioxidants neutralize these harmful compounds and protect your system from many conditions and even symptoms of premature aging like wrinkles, age spots, macular degeneration, and memory loss³⁹.

Effect of Piperine on the GIT and Broncho-Pulmonary System

Piperine quickly elevates the nutrient inclusion as well as the absorption of digestive xenobiotics by exerting the effects on digestive, hepatic and tissue metabolism. It was, however, established that piperine form polar complexes with xenobiotics and nutrients, so it act as a polar molecule. Therefore the compound have proper partitioning due to this they are able to cross the membrane barriers⁴⁰⁻⁴². The studies also reports neuroregulation of the entire GI tract was affected by piperine as it interacts directly with the intestinal epithelial layer which further affects the absorption of food, nutrients and drugs⁴³⁻⁴⁴. Piperine also elevates the gastric emptying and GIT in rats and mice⁴⁵⁻⁴⁶.

Anti-inflammatory Activity

Bang Jun Soo et al studied the inhibitory effects of piperine with reduction of IL6, MMP 13 and PGE production at different concentrations starting from 10 to 100µg/ml but



reduction in the production of PGE2 at minimal dose. At some concentrations, activator protein 1(AP-1) migration also reduced due to the inhibitory activity if the piperine on clinical testing in rats and shown by the histological staining that piperine carries strong anti-inflammatory activity⁴⁷.

Hepatoprotective effect of *P. nigrum*

After Silybum marianum as main hepatoprotector, *P. nigrum* also have hepatoprotective effects in experimental animal's models and in humans. Matsuda et al., observed that when experimental mice with D-galactosamine induced liver toxicity were exposed to dose-dependent piperine, it inhibited increase in serum GPT and GOT levels

and suggested that this inhibitory effect depended on the reduced sensitivity of hepatocytes to tumor necrosis factor $-\alpha$ ⁴⁸.

Antiplatelet Effect of Piperine

Fruits of the *Piper longum* contain piperine, piperonaline, piperocetadecaldine, piperlongumine which shows inhibitory potential on washed rabbit platelet aggregation. All these acid amides shows dose-dependent inhibitory activity on washed rabbit platelet aggregation and the acid amide Piper longumine shows stronger inhibitory effect than other acid amides to rabbit platelet aggregation induced by collagen, AA and PAF⁴⁹.

Table 1: Traditional and Modern uses of Black Pepper⁵⁰⁻⁶¹

Traditional Uses	Animal Based Studies	Human-Based Studies	Cell-Based Studies
Rheumatism	Ant- metastatic	Gastro-intestinal Stimulant	Immunomodulatory Effect
Cold and fever	Enzyme activity stimulator	Anti-asthmatic	Bioavailability Enhancing
Muscular pain	Anti- microbial	Anti-oxidant	Increases Hipper Sensitivity
Flu	Anti-fertility effects	Anti-inflammatory activity	Response
Diuretic	Hepato- protective	Enhancement of food absorption	Increases Increase WBC
Antispasmodic	Biotransformative effect	Lipid metabolism	Enzymatic Activity Enhancer
Increase in saliva flow	Digestive stimulant effect	Anti-diabetic	Anti-oxidant
Antiseptic	Anti-ulcer activity	Anti-hyperlipidemic	Inhibit Lung Metastasis
Dyspepsia	Anti-amoebic activity	Paritel and pepsin secretion	
Coma	Drugs metabolites		
Strep throat	Anti-diarrheal effect		
Blood purifier	Anti-fibrotic effect		
Analgesic	Anti-fungal effect		
Antitoxic	Acaricidal		
Diabetes	Anti-oxidant		
Antipyretic	Glutathione reduction		
Cough			
Carminative			
Appetite stimulator			

Medicinal uses

In the classical literature, many Unani scholars have mentioned various medicinal uses of black pepper;

- It has efficacy to treat cholera, dyspepsia, flatulence, diarrhea, and other gastrointestinal ailments.
- In "Ilaj-ul-Ghurba" a pill is recommended for syphilis, which is prepared by taking black pepper (*P. nigrum*), *Calotropis gigantea*, and jiggery. Externally, it is applied to boils.
- It is also used in case of sore throat, alopecia, skin disorders, and piles. Finely powdered black pepper and sesame oil well mixed and heated, when applied over the paralytic area, is proved to be effective.
- A preparation made with black pepper leaves of *Cassa occidentalis* is good for night blindness.
- It is also used in the treatment of gonorrhea.
- The drug is used as an antidote for scorpion sting⁶².

- The plant *Cissampelos pareira*, in combination with black pepper, has been claimed to be useful in birth control when given immediately after delivery⁶³.
- In Cambodia, it is also used as cure for dysentery⁶⁴.
- The combination of black pepper, onion, and salt, when applied on the bald area, is effective for curing alopecia. When used along with vinegar, it is good for teeth⁶⁵.

Nutraceutical and functional scenario

The black pepper is used in usual medicines as food adjunct to enhance digestive system through a variety of modules, that is, good appetite and absorption, and calculating dyspepsia & fleshiness. However, the accessible health issues that worry mankind mainly include CVDs, diabetes mellitus, inflammatory disease, and cancer insurgence⁶⁶. Several animal studies explicated the role of black pepper as preventive agent against these maladies⁶⁷. Some highlights of the health promoting.



Table 2. Functional and nutraceuticals effect of bioactive compounds of black pepper

Bioactive Compounds	Functional & Nutraceuticals Role	Ref
Piperine	1. Bio-absorption of vitamins and trace elements.	68-69
	2. Effective against acute inflammatory process	70
	3. Antimicrobial properties	71
	4. Improved functionality of gastrointestinal tract.	72
	5. Lowers body weight and visceral fat deposition	73
	6. Improved bioavailability of curcumin and catechins	74
	7. Improved bioavailability of many drugs	75
	8. Piperine ameliorate the chronic mild stress	76
	9. Lowers risk of cancer	77
	10. Decreases the amount of toxicity of certain components	78
Essential oil	1. Produces aroma	79
	2. Control worm infestations	80
Phenolics	1. Diminish oxidation method	81
	2. Ameliorating oxidative stress	82

CONCLUSIONS

In this review *Pepper* is a high source of several biologically active constituents such as monoterpenes, sesquiterpenes, and other volatile compounds. The variety of health beneficial uses and applications of *P. nigrum* and *P. longum* have been recognized by testing on cell, animal, and human subjects. They have been found to have many potential therapeutic applications such as immunomodulator, stimulant, hepatoprotective, anti-inflammatory, antiamoebic, anti-oxidant, anti-carcinogenic, anti-fertility, anti-ulcer, antifungal, antibacterial, antihyperlipidemic, and antiasthmatic. They also originate to have improved bioavailability of food, drug, anti-carcinogen, and phytochemicals which supports to affects on drug-metabolizing enzymes. They bio-transform the metabolite and diminish food components movement and absorption time. This review has shows the pharmacological properties of black and long pepper against human diseases, and some clinical trials have demonstrated the safety and efficacy of pepper in human subjects. Black pepper plant in order to provide sufficient information for future research.

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