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## A COMPREHENSIVE REVIEW ON NUTRITIONAL ASPECTS, CHEMICAL COMPOSITION AND PHARMACOLOGICAL ATTRIBUTES OF BLACK AND WHITE PEPPER

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**ABSTRACT:** Indian spices and medicinal herbs are well known throughout the world. Both have many different physiological and pharmacological characteristics. The current biomedical research is mostly concentrated on finding chemicals extracted from natural sources that are pharmacologically efficient and have little to no side effects for application in food production and preventative medicine. Pepper (*Piper nigrum*) is a common spice found in both Eastern and Western cuisine. It helps in digestion and weight loss by encouraging the breakdown of fat cells and has a remarkable antioxidant and antibacterial impact. Numerous independent researchers have conducted experiments that show pepper and its main ingredient, piperine, to have a variety of physiological effects. *In-vitro* studies have shown that piperine can prevent oxidative damage by suppressing or inhibiting harmful free radicals and oxygen compounds that are reactive. Apart from anti-oxidant property, analgesic, anti-inflammatory, anti-diarrheal, antispasmodic, antidepressant, immunomodulatory, anticonvulsant, anti-thyroid, antibacterial, antifungal, hepato-protective, insecticidal, and larvicidal activities are just a few of the potential pharmacological effects of *Piper nigrum* L and its active component, "Piperine.". The purpose of the current review paper is to present an updated assessment of the literature on recent developments in the nutritional, chemistry, and pharmacological activity of *Piper nigrum* L cultivars.

**INTRODUCTION:** Spices and aromatic plants have been a crucial component of human nutrition since the very beginning of human civilization. For thousands of years, people have used them to enhance the taste, color, and aroma of food. They are valuable for their therapeutic and conserving properties<sup>1</sup>. Additionally, they might help people in sustaining their health by preventing the onset of acute and long-term noncommunicable diseases.

The long history of using herbs and spices for medical purposes is recognized, and there is an increasing amount of research on the potential or claimed health benefits of these foods are needed. These advantages include their potential to provide defense against cancer, cardiovascular disease, neurodegenerative illnesses, and type 2 diabetes mellitus<sup>2-4</sup>.

India has been known as 'land of spices' for being the largest producer and consumer of distinct varieties of spices<sup>5</sup>. India produces around two million tons of spices annually. With an excess of 40 % of the world's spice trade, it is one of the biggest exporters in the globe. Cardamom, fennel, pepper, cumin, coriander, cinnamon, ajwain, clove,

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nutmeg, and mace are well-known Indian spices that are used throughout the world. It's interesting to note that while spices are grown all throughout the world, India alone produces around 50 different varieties, each with its distinct flavor and medical benefits. Culinary herbs and spices are foods that are abundant sources of bioactive molecules, including tannins, alkaloids, phenolic diterpenes, Sulphur-containing compounds, and vitamins, particularly flavonoids and polyphenols<sup>6-10</sup>. According to several preclinical researches, phytochemicals are more effective than synthetic substances at preventing colon cancer and others<sup>11, 12</sup>. Functional foods are those that have been clinically demonstrated to have documented health advantages for the prevention, management, or treatment of chronic diseases and contain these biologically active components in specific, efficient, non-toxic levels<sup>13</sup>.

Pepper (*Piper nigrum*), also known as “The King of Spices,”<sup>14</sup> is one of highly useful Indian medicinal herbs that has a significant high amount of functional ingredients with health-promoting effects coupled with aromatic and medicinal components. The Piperaceae family, which consists of 13 genera, is thought to be one of the oldest flowering plant families found in tropical regions. Pepper species are part of this family<sup>15</sup>.

### Review of Literature:

**Habitat:** Pepper grows well between 0 and 500 m above sea level, but it thrives at 100 m. The ideal annual rainfall is between 2000 and 3000 mm, with two dry months to promote flowering. The ideal air temperature range is between 23 and 32 °C, with a daytime high of 29 °C. The soil under consideration is thin, loose, permeable, and fertile. Growing pepper plants from seeds is uncommon. Ripe fruit is used to harvest the seeds, which are then massaged out, cleaned, and dried by the wind. 3–4 weeks after the seedlings start to grow, spread the seeds right away in sand beds. At two months old, seedlings can be moved to the main nursery. Before planting 1-metre-long, 7-segment cuttings in the garden, little cuts with 1-3 segments must first be seeded. When book cuttings (one leaf) are seeded on a sand substrate and allowed to sprout for one to two months, they can be put in a plastic bag. When seedlings reach a length of seven sections and are ready to be planted in the garden,

they are kept under the roof for about three to four months<sup>16, 17</sup>.

**Plant Morphology:** The pepper plant **Fig. 1** features unbranched, single-axis, panicle-shaped blooms that are 3–25 cm long, and flowers are positioned opposite the leaves of the branches. Compound flowers include the pepper flower. It has a pale greenish-yellow hue. The panicles droop to various heights. Simply female; only male or hermaphrodite (bisexual) pepper flowers are available. One ovule makes up the single-celled female genitalia.

The ovary is surrounded by 350 stigmas. There are 2-4 short stamens on either side of the female genitalia, and each one has two theca, or essence-filled pouches. Protogenic pepper blossoms exist. At first, eyes were the potential flowers. The sprout develops into a bud that is sheathed in a leaf as it approaches the flowering stage<sup>16, 18-20</sup>.



**FIG. 1: THE MATURE PEPPER PLANT**

**Processing and Usage of Black and White Pepper:** Black and white peppers **Fig. 2** are processed differently and harvested at different times. Black pepper contains pulp because it is made by drying unripe fruit until a wrinkle develops, but white pepper is made by removing the pulp from mature fruit. Both black and white pepper can be used as insecticides, spices, culinary preservatives, and more<sup>21, 22</sup>.



FIG. 2: TWO DIFFERENT CULTIVARS OF PEPPER [A: BLACK PEPPER; B: WHITE PEPPER]

Due to its growing recognition as a significant source of plant-based antioxidants with anticarcinogenic action, pepper is increasingly being used in a variety of industries, including food production, the pharmaceutical industry, and others<sup>23, 24</sup>.

Both as a medication and in various dishes, *Piper nigrum* or its active ingredients are employed. Pepper is used in a variety of foods preparation, including meat dishes, all over the world. Black pepper is mostly used in Western cuisine as a spice to increase food flavour and in food preservation<sup>25</sup>.

In Thai and Chinese cooking, ground white pepper is used to prepare dishes such as salads, cream sauces, and light-coloured sauces. It includes the potent piperine, basically an alkaloid, noted for its variety of intriguing pharmacological effects. It is frequently used in various conventional medical systems, including the Ayurvedic and Unani systems of medicine<sup>26</sup>.

#### **Taxonomical Classification<sup>27</sup>:**

**Kingdom:** Plantae

**Subkingdom:** Tracheobionta

**Superdivision:** Spermatophyta

**Division:** Manoliophyta

**Class:** Magnolopsida

**Subclass:** Magnoliidae

**Order:** Piperales

**Family:** Piperaceae

**Genus:** *Piper*

**Species:** *Piper nigrum*

The scientific community has done substantial research on this plant's biology, and a ton of literature has been generated as a result. However, an updated collection of these data is not yet available to give a comprehensive profile of both the black and white varieties of *P. nigrum* therapeutic properties. In light of this, the objective of this work was to thoroughly analyze the available scientific data on the pharmacological and traditional uses of *P. nigrum*.

**Process of Data Collection:** The approach utilized to write this review article required looking for sources or literature from the previous 22 years (2000–2022) in the form of original information, authorized book forms, and national and international publications. This review article was then created, and data was searched for using online media using the keywords *Piper nigrum* L., the chemical content of *Piper nigrum* L., and the pharmacological activity of *Piper nigrum* L. The main sources for this review article's references were found on reputable websites, including Science Direct, Research Gate, Google Scholar, and other well-read and cited periodicals.

**Nutritional Components of *P. nigrum*:** The plant *P. nigrum* is full of vitamins and nutrients. 10 gms of protein, 66.5 gms of polysaccharide, and 10.2 gms of lipid are found in every 100 gms of pepper seeds<sup>28</sup>. While salt, iron, and zinc are present in relatively small amounts, potassium (1200 mg), phosphorus (160 mg), and magnesium (235.8–249.8 mg) are among the minerals that are present



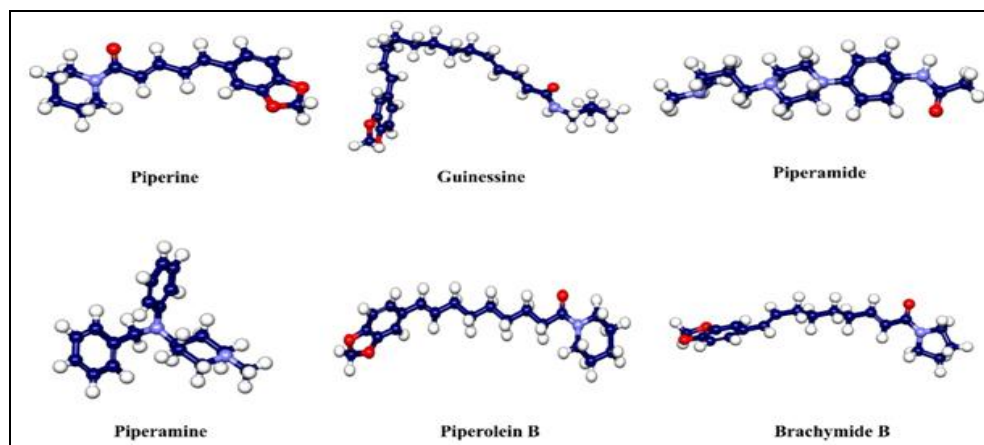
in quite significant percentages<sup>29</sup>. These minerals are crucial components of human daily life. In addition, black pepper contains a lot of vitamins, including Vitamins C, B subtypes **Table 1**. In a recent study on black pepper, literature noted the presence of considerable concentrations of lutein and beta-carotene as well as flavonoids such as catechin, quercetin, and myricetin **Table 1**<sup>28-30</sup>.

**TABLE 1: NUTRITIONAL COMPONENTS PER 100 GM. OF *P. NIGRUM***

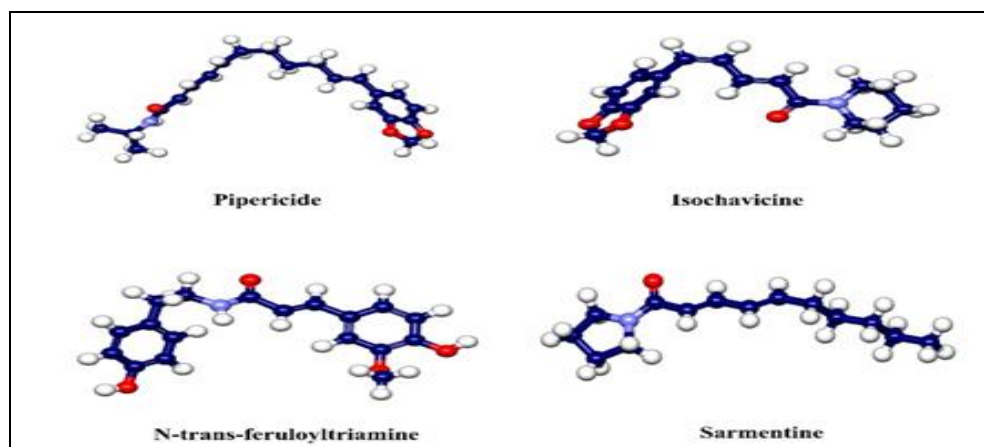
Chemical Composition	Concentration
Nutritional	
Vitamin C (mg.)	27.46-32.53
Vitamin B1(mg.)	0.74-0.91
Vitamin B2(mg.)	0.48-0.61
Vitamin B3 (mg.)	0.63-0.78
Phytometabolites	
Flavonoids	
Catechin (ug.)	410.0
Quercetin (ug.)	13.0
Myricetin(ug.)	56.0
Tannin (mg.)	2.11-2.80
Carotenoids	
Lutein (ug.)	260.0
B-carotene(ug.)	150.0

**Chemical Composition of *P. nigrum*:** Numerous researchers have identified a wide range of phytochemicals, including polyphenolics, alkaloids, amides, lignans, terpenes and chalcones, *etc.* Among the substances are Brachyamide B, Dihydro-Pipericide, (2E, 4E)-N-Eicosadienoyl-Piperidine, N-trans-Feruloyltryamine, N-Formyl-Piperidine, Guineensine, and Pentadienoyl-Piperidine.

Piperamide, Piperamine, Piperettine, Pipericide, Piperine, Piperolein B, Sarmentine, Sarmentosine, Isobutyl-Idecadienamamide, Isobutyl-eicosadienamamide, Triolein, Trichostachine, Isobutyl-eicosatrienamamide, Isobutyl-octadienamamide. These phytochemicals' presence was cited as the reason for the documented variety of pharmacological actions. According to reports, piperine comes in four isomers: Isochavicine, piperine, isopiperine, and chavicine among all *P. nigrum*-derived isolated chemicals. It was found that piperine and its derivatives had different pharmacological effects **Fig. 3A** and **3B**<sup>22, 23, 31-33</sup>.



**FIG. 3A: 3D STRUCTURES OF CHEMICAL COMPOUNDS FOUND IN *P. NIGRUM* OIL**



**FIG. 3B: 3D STRUCTURES OF CHEMICAL COMPOUNDS FOUND IN *P. NIGRUM* OIL**

It also contains a wide range of fragrant and volatile chemicals and has potential applications in cosmetics, perfumes, medicine, and culinary spices.

**Table 2** provides a summary of some of the categorised aromatic and volatile components of pepper.

**TABLE 2: DIFFERENT AROMATIC AND VOLATILE COMPONENTS PRESENT IN *P. NIGRUM***

Monoterpenoids	Sesquiterpenoids	Other Category
Sabinene	Caryophyllene oxide	Cinnamic acid
Limonene	$\alpha$ -Copaene	Eugenol
Camphene	$\alpha$ -Cubebene	Myristicin
Myrcene	$\alpha$ -Selinenes	Piperonic acid
Terpinolene	$\beta$ -Bisabolene	Piperonal
$\alpha$ -Pinene	$\beta$ -Caryophyllene	Safrole
$\beta$ -Pinene		Phenyl acetic acid
$\alpha$ -Thujene		
$\beta$ -Phellandrene		
$\gamma$ -Terpinene		

### Pharmacological Activities:

#### Therapeutic Characteristics of White Pepper:

There are a number of biological actions of white pepper that tend to be noteworthy, according to various published papers.

**Anticarcinogenic:** White pepper protects against the development of cancer by reducing the generation of free radicals. Capsaicin, present in pepper mainly lowers the risk of prostate cancer, which is regarded as a serious illness.

**Anti-inflammatory:** Inflammation generates inside the muscles and arthritis are both reduced by white pepper, that make it helpful in the treatment of muscle cramps.

**Preventing Respiratory Problems:** White pepper has the potential to treat respiratory problems. In winter season, white pepper is considered to be effective in preventing certain chest discomfort. Decongestants and nasal passageways are cleared by white pepper.

**Lowering Blood Pressure Level:** The phyto-molecules including the nutritional components help in reducing high blood pressure and thus providing benefit to cardiovascular health. It also inhibits the chances of heart attacks. Thus, white pepper is a great addition to the diet for seniors.

**Anti-arthritis:** A well-known food for easing joint and back pain is white pepper. The relaxation from osteoarthritis and gout attacks, which cause excruciating physical pain, is a huge advantage for elderly individuals. The muscles can also be strengthened with white pepper. This makes

movement easier and lessens the likelihood of muscle cramping.

**Anti-obesity:** White pepper has a high concentration of capsaicin, which is best recognised for its ability to burn fat. White pepper consumption results in a loss of extra body weight. This is why white pepper is more advantageous and has fewer negative effects than capsaicin, which is also present in many fake weight-loss medications.

**Induce Potency in Male:** according to some scientific researches, problem of impotency in male can be treated mixing white pepper with coffee. It boosts the process of spermatogenesis followed by releasing of sperms<sup>16, 34, 35</sup>.

**Therapeutic Characteristics of Black Pepper:** According to numerous published articles, black pepper has the following pharmacological properties that make them especially important.

**Antioxidant:** Food products include antioxidant molecules that are vital health-protective elements<sup>36</sup>. An excellent source of antioxidants is black pepper. In fact, black pepper increases and maintains the levels and effectiveness of vital antioxidant chemicals<sup>33</sup>. Numerous of these substances function indirectly by boosting the effects of other antioxidants in addition to their intrinsic antioxidant properties. Saturated lipids in meals create oxidative stress, which black pepper reduces. This study demonstrated an antioxidant preventative role for Piper species extracts against oxidative stress brought on by an atherogenic diet in the renal, cardiac, and hepatic tissues<sup>32, 37-39</sup>.

**Anti-inflammatory:** Black pepper is an example of an anti-inflammatory drug, that lowers inflammation in the human body<sup>36</sup>. About 50% of analgesics are anti-inflammatory medicines, which treat pain by lowering inflammation. In IL1-stimulated human FLS, piperine was found to drastically reduce the levels of two key mediators of inflammation, IL6 and PGE2. Due to PGE2's crucial function in causing pain, its synthesis must be inhibited. By using both the ELISA and RT-PCR techniques for analysis, the levels of prostaglandin E2, which is cyclooxygenase 2, interleukin-6 (IL-6), and matrix metalloproteinase were assessed. While NF-κB migration was unaffected by piperine, activator protein 1 migration into the nucleus was decreased in interleukin-1-treated synoviocytes. Piperine greatly lessened the discomfort and symptoms of arthritic disease in rats<sup>40</sup>.

**Anticarcinogenic:** Pepper substantially boosts the strength and effectiveness of other anti-tumour spices by increasing their bioavailability. Black pepper directly inhibits the growth of cancer. Its main phytochemical, piperine, blocks the production of some pro-inflammatory cytokines by tumour cells. Safrole and tannic acid, two insignificant pepper components, are thought to have negligible carcinogenic potential. Studies show that there are certain substances are both carcinogenic and anti-carcinogenic<sup>3, 41-44</sup>.

**Cholesterol Lowering:** By accelerating the breakdown of bigger fat molecules into more easily digested simple molecules, black pepper improves the digestive process and stops the body from storing fat<sup>45, 46</sup>.

**Antimicrobial:** There are multiple studies in the literature that have examined the antibacterial potential of an aqueous extract of *Piper nigrum* L. (black pepper) against various oral cavity pathogen<sup>47</sup>.

At a concentration of 10 ul. /Disc, the aqueous decoction of black pepper exhibited the greatest antibacterial activity, comparable to other spices. Black pepper mediated metal nanoparticles also show a positive antibacterial activity against various plant pathogens. This data supports the antibacterial properties of silver nanoparticles as a

useful implementation in the area of agricultural for their purpose of crop protection and improvement<sup>48</sup>.

**Digestive Stimulant:** Numerous spices have a stimulating effect on the digestive system. By boosting pancreatic enzymes, dietary piperine speeds up digestion and reduces how long food travels through the digestive tract. According to some reports, piperine induces gastric and salivary secretions as well as the generation and activation of salivary amylase<sup>14, 49</sup>.

**Analgesic:** Piperine was tested for its *in-vivo* analgesic effects on mice. Findings from tail flick assay models demonstrated that piperine has analgesic properties that may be mediated by the opioid system<sup>50</sup>.

**CONCLUSION:** According to the studied literature, the plant *Piper nigrum* (L.) possesses a variety of advantageous chemical characteristics that have beneficial effects. Black pepper, in particular, is exceptionally abundant in a wide range of chemical components, the majority of which have biological activity. Since it has been used for so long in various traditional medical practices, pepper has been used in everything from medications to cosmetics to cooking. The importance of its employment in conventional medical systems is revealed by contemporary experimental studies on its many biological activities.

Numerous scientific analyses of its volatile components, including monoterpenes, sesquiterpenes, and particularly piperine, have expanded the field of research evaluating its medicinal and other uses. Additionally, synthetic alterations were made to provide a more potent therapeutic candidate with low toxicity and significant importance. There are currently new studies being conducted that use alternative formulations, application techniques, and delivery methods with pepper as the primary ingredient. The future appeal of the pepper is indicated by its use in the treatment of tumors, obesity, hypertension, diabetes, diarrhea, and its bioavailability. Furthermore, particular studies are required to prove that the black pepper is, in fact, the King of the species.

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