www.ijarp.com ISSN 2456-9992 Page: 01-13

International Journal Advanced Research Publications

Research Article

Volume: 02
Issue: 04

BLACK PEPPER BOTANICAL ASPECTS, CHEMICAL CONTENT, PHARMACOLOGICAL ACTIVITIES

***Mr. Prabhat Mishra, Mr. Awan Kumar Pandey (Assistant Professor)**

India.

Article Received: 03 March 2026, Article Revised: 23 March 2026, Published on: 13 April 2026

***Corresponding Author: Mr. Prabhat Mishra**

India.

DOI: https://doi-doi.org/101555/ijarp.4876

ABSTRACT

Black pepper (*Piper nigrum*) possesses numerous health benefits and is widely used in daily life. Its most common application is as a culinary spice due to its characteristic pungent flavor. Black pepper is among the oldest known spices and is extensively utilized in cooking as well as in the healthcare sector, particularly in traditional medicine, where it is regarded as the "king of spices."

The information used in this study was collected from online databases such as Google Scholar, ResearchGate, ScienceDirect, as well as books on black pepper and reputable scientific journals published between 2000 and 2020. Traditional medicine utilizes natural plant resources, including roots, stems, branches, leaves, flowers, and fruits, which are relatively easy to obtain. In addition to having minimal side effects, these natural remedies can be used for prolonged periods.

The primary bioactive constituents of black pepper, mainly piperine and essential oils, exhibit a wide range of pharmacological activities, including antioxidant, antifungal, antimicrobial, and antiepileptic effects, as well as libido enhancement and anti-diarrheal properties, among others. Based on these properties, extensive research has been conducted on the phytochemical composition and pharmacological activities of black pepper.

INTRODUCTION

Spices are defined as plant-derived materials used to enhance the flavor of food. These include various plant parts such as bark, flowers, fruits, roots, leaves, rhizomes, seeds, tubers, and other botanical components. Spices are aromatic or strongly flavored plant substances that are typically used in small amounts in food preparation as preservatives or flavoring agents in

cooking [1].

Indonesia is a country rich in spice diversity, one of which is pepper. Pepper is mainly classified into two types: black pepper and white pepper. Black pepper (*Piper nigrum* L.) is a highly valuable medicinal plant and is therefore widely referred to as the "king of spices" [2].

Black pepper is utilized globally in a wide variety of culinary preparations. In addition, it has been employed in traditional medicine for treating multiple diseases since ancient times. It serves important roles in therapeutics, food preservation, and flavor enhancement [3], as well as in the cosmetic and perfume industries. Furthermore, it is extensively used as a medicinal ingredient, either alone or in combination with other components [4]. In Indonesia, *Piper nigrum* L. is reported to exhibit antimicrobial, antihypertensive, anti-plasmodial, anti-inflammatory, hepatoprotective, and antioxidant activities [2].

Black pepper has been traditionally used for generations and is well recognized in Indonesian ethnomedicine [5]. Therefore, the authors are interested in reviewing black pepper from its botanical characteristics, phytochemical constituents, and pharmacological activities.

Data Collection

In preparing this review article, a literature review approach was employed by collecting information from primary sources, including authoritative books and peer-reviewed national and international journals published within the last 20 years (2000–2020). The data were gathered using online databases with keywords such as *Piper nigrum* L., chemical constituents of *Piper nigrum* L., and pharmacological activities of *Piper nigrum* L. The main references were obtained from reliable platforms such as ScienceDirect, ResearchGate, Google Scholar, and other credible scientific journal sources.

Botany Aspect

Classification of the pepper plant [6]:

Kingdom : Plantae (Plant) Subkingdom : Tracheobionata

Super divisi : Spermatophyta (Seed plant)

Divisi : Magnoliopsida (Two pieces/dicotyledon) Kelas : Magnoliidae

Sub-kelas : Monocotyledonae Ordo : Piperales

Famili : Piperaceae (the Betel Tribe) Genus : Piper

Spesies : Piper nigrum L

Figure 1: Black pepper plant (Piper nigrum L.) [7]

Morphology and Growth Characteristics of Pepper Plant

Morphologically, the pepper plant is a perennial climbing and spreading vine (Figure 1). Its stem is robust and jointed (nodal), and the plant can reach a height of up to 10 meters with a canopy diameter of approximately 1.5 meters. The plant consists of several parts, including roots, stems and branches, leaves, flowers, fruits, and seeds [8].

The pepper plant possesses two types of root systems. The first type comprises roots that develop from nodes in the soil, forming lateral nodal roots that function primarily in nutrient and water absorption. The second type includes aerial adhesive roots that arise above the ground and help the plant attach to supports. The lateral roots are fibrous at the lower stem region and originate from the taproot system. Typically, a pepper plant develops about 10–20 roots, which may extend 3–4 meters in length, while the root system can penetrate soil depths of 1–2 meters. In contrast, the aerial adhesive roots emerging from stem nodes are short, non-elongated, and usually measure around 3–5 cm in length [8].

The stem of pepper is a long, cylindrical, and jointed vine. Young stems are green in color, whereas mature stems become woody with a diameter of about 4–6 cm. The nodes or internodes may reach lengths of 5–12 cm. Pepper is a dimorphic plant, exhibiting two main types of

shoots: climbing shoots and fruiting shoots. Climbing shoots possess nodes with well-developed adhesive roots but do not produce fruits. Fruiting shoots exhibit a sympodial branching pattern and grow horizontally (plagiotropic growth). These fruiting branches lack adhesive roots. Fruiting shoots are positively phototropic, whereas climbing shoots are negatively phototropic. In addition, pepper plants may also develop hanging shoots and ground (soil) shoots. Hanging shoots grow depending on the surface of the canopy, while soil shoots develop along the ground surface. Both types possess relatively long internodes, thicker stems, narrower leaves, and lack adhesive roots. Anatomically, hanging and soil shoots originate from climbing shoots and are considered inferior shoots; therefore, they are usually removed through pruning practices [8].

Pepper leaves are simple, alternate, and borne singly at each node. They are ovate to cordate in shape with an asymmetrical base and a pointed apex. The petiole length ranges from 1.8–2.6 cm. The leaf base is blunt or slightly notched, while the apex is acuminate. Leaf size varies from 5–10 cm in width and 10–19 cm in length. The venation consists of a central midrib with 3–4 pairs of lateral veins that curve outward [8].

The inflorescence of pepper is spike-like (catkin-shaped), measuring approximately 3–25 cm in length. It is unbranched and bears more than 150 small sessile flowers arranged along a single axis opposite the leaves. The flowers are greenish-yellow in color and hang downward in clusters of varying lengths. Pepper flowers may be female, male, or hermaphroditic (bisexual). Female flowers contain a single ovule and a centrally located ovary surrounded by three stigmas. On either side of the female reproductive structure, 2–4 short stamens are present, each containing two anther sacs (thecae). Pepper flowers are protogynous in nature. Initially, floral primordia appear as small buds, which later develop into flower clusters protected by a leaf sheath [8].

The fruit of pepper is generally spherical or slightly oval in shape. It exists in different forms depending on maturity. Normal fruits turn green when immature and become red to orange upon ripening. Abnormal fruits are smaller, dark green, and eventually turn black upon drying. The pericarp is about 1–2 mm thick. In young fruits, the skin is hard, whereas in mature fruits it becomes soft, juicy, reddish-orange, and easily detachable. The fruit contains essential oils, oleoresins, and piperine, with varying concentrations depending on the variety [8].

Pepper seeds are small, with a smooth surface and a seed coat that may appear white or brown, measuring about 3–4 mm in diameter. The embryo is located near the micropyle region. Oil content is mainly concentrated in the seed coat [8]. In different regions, pepper is also known by local names such as pedes, saang, sakang, or merica [9].

Pepper grows best in tropical regions at altitudes of 0–500 meters above sea level, although optimal growth occurs around 100 meters. It requires an annual rainfall of 2000–3000 mm with approximately two dry months to promote flowering. Excessive rain and strong winds may cause shedding of flower spikes and reduce fruit yield. The ideal temperature range is 23–32°C, with an average daytime temperature of around 29°C. The plant thrives in light, loose, well-drained, and fertile soils.

Pepper is not commonly propagated directly from seeds. Seeds are obtained from fully ripened fruits, which are crushed to extract seeds, washed, and air-dried. They are then sown immediately in sand beds and germinate within 3–4 weeks. After 2 months, seedlings are transferred to a nursery. Stem cuttings of about 1 meter with 7 nodes can be directly planted in the field, whereas shorter cuttings (1–3 nodes) require pre-nursery treatment. Single-node cuttings with one leaf are first planted in sand beds; after sprouting within 1–2 months, they are transferred to polybags. Seedlings are maintained under shade for 3–4 months until they reach approximately 7-node length and are ready for field transplantation [10].

Chemical Content

Black pepper contains a wide range of phytochemical constituents, including saponins, flavonoids, essential oils, chavicine, resins, proteins (albumin), starch, piperine, piperlongumine, piperolein, piperanine, dihydrocarveol, caryophyllene oxide, carvone, trans-piperol, and volatile pepper oil [11].

Saponins

Phytochemical analysis of *Piper nigrum* L. using the Folin–Ciocalteu method revealed that saponins are present in the extract at a concentration of 0.06% [12]. Saponins, along with tannins present in *Piper nigrum* extracts, are reported to provide protective effects against hypercholesterolemia and exhibit antimicrobial activity [13].

Flavonoids

Phytochemical screening has confirmed that *Piper nigrum* L. simplicia tests positive for flavonoid compounds [14]. Another study reported that black pepper fruit extract contains measurable flavonoids. Using UV spectrophotometric analysis of methanolic extracts, the total flavonoid content was found to be approximately (1.728 ± 0.049) mg/g and (1.087 ± 0.002) µg/g, respectively [15].

Essential Oils

One study reported the extraction of essential oil from black pepper (*Piper nigrum* L.) using

2.2 kg of ground dried pepper via steam distillation for approximately 6 hours, following the optimal conditions outlined in SNI 0005:2013 standards for black pepper. The obtained oil was treated with anhydrous Na_2SO_4 to remove residual moisture. The yield of essential oil was 28 mL, corresponding to 1.27% [16].

Another investigation extracted essential oils using 200 g samples of fresh pepper, dried pepper, and pepper leaves through water distillation using a Clevenger apparatus for 5 hours. The average yields obtained from three replications were 2.2% for fresh pepper, 2.0% for dried pepper, and 1.2% for pepper leaves [17].

Chavicine (Isomeric Forms of Piperine)

Piperine exists in four stereoisomeric forms, namely piperine (trans–trans isomer), isopiperine (cis–trans isomer), chavicine (cis–cis isomer), and isochavicine (trans–cis isomer) (Figure 2).

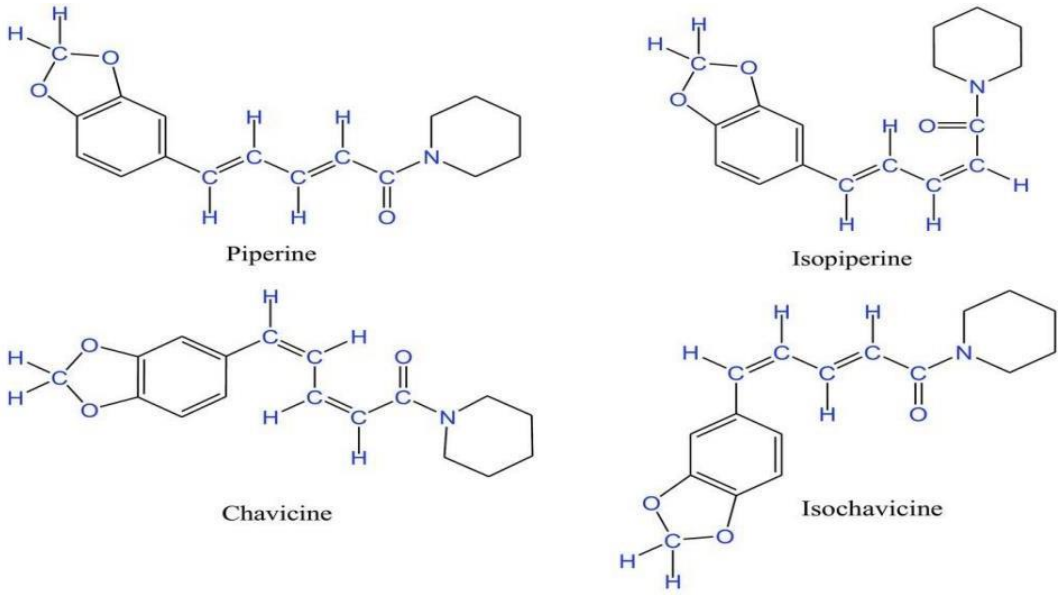

Figure 2: Chemical Structure of Piperine, Isopiperine, Chavicine, Isochavisin [18].

Piperine

Piperine (piperinoyl-piperidine) is a pungent nitrogen-containing alkaloid present in black pepper. It represents the principal bioactive compound of pepper and belongs to the pyridine alkaloid group. Piperine is utilized in various pharmaceutical applications, including cough formulations, anti-malarial drugs, and anti-inflammatory agents. The average piperine content in black pepper is approximately 6%, whereas in oleoresin form it ranges between 25.74% and 48.32% [19]. The isolated piperine alkaloid exhibits multiple pharmacological properties such as antimicrobial, antioxidant, anti-inflammatory, anticancer, antidepressant (relaxant), and analgesic activities [7].

Experimental studies have demonstrated the presence of piperine in both black and white pepper (*Piper nigrum* L.) extracts using ethanol of varying concentrations analyzed through TLC-densitometry. Quantitative determination of piperine in the alkaloid fraction of black pepper showed that the highest content (52.81%) was obtained from extracts prepared using 60% ethanol. It was further observed that increasing ethanol concentration resulted in a reduction in piperine yield in the extract [20].

Another investigation utilized Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS) to determine piperine content in black pepper fruit extract. The study reported that 96% ethanol extract contained approximately 26% piperine based on LC-MS analysis [21].

Piperylline, Piperoleine, Piperanine

According to Singh et al. (2004), black pepper extract contains several alkaloids, with piperine being the major constituent (33.53%), followed by piperolein B (13.73%) [22]. Apart from piperine, most isomeric compounds do not contribute to the characteristic pungent taste. However, compounds such as piperanine, piperettine, piperylline A, piperolein B, and piperine collectively contribute to a slightly sharp and aromatic flavor profile in black pepper extract [23].

Pharmacological Activities

Black pepper exhibits a broad spectrum of pharmacological properties as reported in various scientific studies, as outlined below:

Antioxidant Activity

Antioxidant potential was evaluated using leaf extracts from four Piper species, including *Piper nigrum* L., *Piper aduncum*, *Piper retrofractum*, and *Piper crocatum*. A stock solution (100 µg/mL) was prepared and serial dilutions were made, with vitamin C used as a reference standard. The samples and standards were reacted with DPPH solution in a 1:1 ratio, and absorbance was measured using UV-Vis spectrophotometry at 516 nm [24].

Results indicated that ethanol extract of *Piper nigrum* L. leaves exhibited the highest antioxidant activity with an IC_{50} value of 57.72 µg/mL, classified as strong antioxidant activity [14][24].

Flavonoids possessing flavone and flavanone structures demonstrate strong antioxidant properties due to hydroxyl groups on ring B and substitutions at the C3 position of ring C [25].

Additional studies confirmed antioxidant activity of *Piper nigrum* L. using cold and methanolic extracts via DPPH assay, with an inhibition rate of 78.81% at 200 µg/mL concentration. This

antioxidant potential is attributed mainly to flavonoid and phenolic constituents [2][26].

Antimicrobial Activity

Antimicrobial activity of *Piper nigrum* L. extract was assessed using the disc diffusion method against bacterial strains. The methanolic extracts obtained through both hot and cold extraction methods were tested using Mueller-Hinton agar following CLSI guidelines. Results showed inhibitory activity against *Escherichia coli* [26].

Phenolic compounds, widely distributed in plant metabolic pathways such as the pentose phosphate, shikimate, and phenylpropanoid pathways, play a crucial role in plant defense mechanisms and contribute to antimicrobial activity [27].

Libido Enhancement

Studies have demonstrated that black pepper (*Piper nigrum* L.) extract enhances libido in male mice (*Mus musculus* L.) of different age groups. Mating behavior tests conducted at the end of treatment showed that extract administration reduced mounting latency in aged male mice and increased mounting frequency in younger mice [28].

The active compound piperine acts as an antioxidant and contributes to improved physiological performance. It influences the vomeronasal system, enhancing detection of female pheromones, which are transmitted to the amygdala and medial preoptic area (MPOA). Piperine is also reported to increase gonadotropin levels by reducing negative feedback on the pituitary gland in male mice [29]. Testosterone plays a key role in regulating sexual behavior by enhancing sensory response to pheromonal signals, thereby influencing mating activity [30]. Further studies also confirmed that black pepper extract positively affects sexual behavior in male mice through behavioral mating assessments [31].

Antibacterial Activity

Antibacterial testing was performed against *Staphylococcus aureus* and *Escherichia coli*. Results showed that ethanol extract of pepper leaves exhibited strong inhibitory activity, with 8.3% inhibition against *S. aureus* and 7.73% against *E. coli*, compared to ethyl acetate extracts. However, no antifungal activity was observed against *Candida albicans*. Both extracts demonstrated the ability to inhibit microbial growth to varying extents [32].

The antimicrobial properties of pepper leaves are attributed to the presence of bioactive compounds such as tannins, phenols, coumarins, alkaloids, and anthraquinones. Alkaloid content (5–9%) includes major compounds such as piperine, piperidine, piperettine, and piperazine [33].

Additionally, chloroform extracts of black pepper have been shown to inhibit food spoilage and pathogenic bacteria. The antimicrobial mechanism involves disruption of bacterial cell morphology, interference with respiratory metabolism, reduction of pyruvic acid levels, and depletion of ATP in target microorganisms such as *E. coli* and *S. aureus* [34].

Anti-Seizure Activity

An experimental study investigating the anticonvulsant (anti-seizure) effect of piperine utilized a single intraperitoneal injection of pentylenetetrazole (PTZ) at a dose of 75 mg/kg in animal models. The administration of PTZ induced tonic–clonic seizures lasting approximately 1.79 ± 0.32 minutes and resulted in 100% mortality in untreated subjects. In contrast, animals treated with diazepam (5 mg/kg, intraperitoneally) did not exhibit seizure activity and showed complete protection against mortality.

Piperine was administered at doses of 5 mg/kg, 10 mg/kg, and 20 mg/kg. Results indicated that doses of 5 mg/kg and 20 mg/kg did not provide significant protection against mortality. However, the 10 mg/kg dose demonstrated approximately 60% protection against PTZ-induced seizure mortality [35].

In vivo findings further revealed that piperine significantly delayed the onset of seizures in the PTZ model, suggesting involvement of GABA $_A$ receptor modulation and glycinergic neurotransmission pathways. Additionally, acute administration of piperine increased GABA levels in the cerebral cortex and hippocampus, indicating a potential anticonvulsant mechanism through enhancement of inhibitory neurotransmission [35].

Antidiarrheal Activity

Research has demonstrated that black pepper extract possesses antidiarrheal properties in experimental animal models induced by castor oil, magnesium sulfate, and intestinal transit stimulation tests. A dose of 300 mg/kg showed significant inhibition of diarrhea compared to the control group.

The antidiarrheal effect is attributed to both anti-secretory (reduction of gastric and intestinal fluid secretion) and antimotility actions, as the extract delays gastrointestinal transit, thereby increasing absorption time within the intestine. Phytochemical screening suggests that carbohydrates and alkaloids are primarily responsible for these effects, providing a scientific basis for the traditional use of black pepper as an antidiarrheal agent [36].

Further studies have confirmed that piperine significantly reduces castor oil–induced intestinal fluid secretion. Oral administration of piperine at a dose of 20 mg/kg markedly decreased fluid

accumulation in the small intestine of mice, supporting its role in regulating intestinal secretory activity [37].

CONCLUSION

Black pepper (*Piper nigrum* L.) is a widely used culinary spice known for its characteristic pungent flavor and extensive application in cooking. It is a climbing perennial plant that grows by attaching to support structures. The plant contains several bioactive compounds, particularly piperine and essential oils, which are extensively utilized in traditional medicine.

Pharmacologically, black pepper exhibits a wide range of biological activities, including antioxidant, antimicrobial, libido-enhancing, antibacterial, anticonvulsant (anti-seizure), and antidiarrheal effects. These diverse therapeutic properties highlight its significance as a valuable medicinal plant in both traditional and modern pharmacological systems.

REFERENCES

1. No Title [Internet]. Available from: https://id.wikipedia.org/wiki/Rempah-rempah.
2. Damanhouri ZA, Ahmad A. A Review on Therapeutic Potential of Piper nigrum L. (Black pepper): The King of Spices. Medicinal and Aromatic Plants. 2014;3(3). 3-6. Available from: http://dx.doi.org/10.4172/2167- 0412.1000161. [3] Ahmad N, Fazal H, Abbasi BH, Farooq S, Ali M, Khan MA. Biological role of Piper nigrum L. (Black pepper): A Review. Asian Pac J Trop Biomed. 2012;1691.
3. Ali AA, Ahmad J, Kapoor P, Jahangir U, Parveen S, Khan QA. Efficacy of Piper nigrum(Black pepper): A Review. 2016;4(4):5–7.
4. Boangmanalu RK, Zuhrotun A. Review Artikel : Potensi Khasiat Obat Tanaman Marga Piper : Piper nigrum L., Piper retrofractum Vahl., Piper betle Linn., Piper cubeba L. dan Piper crocatum Ruiz & Pav. Farmaka. 2018;16(3):204–12.
5. No Title [Internet]. Available from: http://plantamor.com/species/info/piper/nigrum.
6. Vasavirama K, Upender M. Piperine : A Valuable Alkaloid From Piper Species. Int J Pharm and Pharm Sci. 2014;4(4).34-38.
7. Yudiyanto. Tanaman Lada dalam Perspektif Autekologi. Bandar Lampung: Anugrah Utama Raharja; Bandar Lampung. 2016.1-128 hal.
8. Utami P, Lentera T. Tanaman Obat Untuk Mengatasi Rematik & Asam Urat. Depok : Pt.Agromedia Pustaka.2006.1-124 hal.
9. Evizal R. Tanaman Rempah dan Fitofarmaka. Badar Lampung : Lembaga Penelitian Bandar Lampung : 2013. 1– 196 hal.

10. Cholis N. Ensiklopedia Obat-Obatan Alami. Jawa Tengah : Alprin Semarang Selatan. 2010. 1–130 p.
11. Ali M, Shinkafi S., Farouk SNF. Phytochemistry and Antibacterial Activity of Black Pepper (Piper nigrum) Seeds Extracts on Some Food-Borne Pathogens. Int J Pharm Sci Kosm Publ. 2018;1(1):1–8.
12. Okwu D. Evaluation Of The Chemical Composition Of Indigenous Spices and Flavouring Agents. Glob J Pure Appl Sci. 2001;7(3):455–459.
13. Insane M, Marliani L, Dinilah NP. Comparison of Antioxidant Activities from Four Species of Piper. Pharmacia. 2017;7(2):305–312.
14. Ahmad A, Husain A, Mujeeb M, Khan SA, Alhadrami HAA, Bhandari A. Quantification of Total Phenol, Flavonoid Content and Pharmacognostical Evaluation Including HPTLC Fingerprinting for the Standardization of Piper nigrum Linn fruits. Asian Pac J Trop Biomed. 2015;5(2):101–107. Available from: http://dx.doi.org/10.1016/S2221-1691(15)30152-0 .
15. Anggraini R, Jayuska A, Alimuddin AH. Isolasi dan Karakterisasi Minyak Atsiri Lada Hitam (Piper nigrum L.) Asal Sajingan Kalimantan Barat. J Kim Khatulistiwa. 2018;7(4):124–133.
16. Sasidharan I, Menon AN. Comparative Chemical Composition and Antimicrobial Activity of Berry and Leaf Essential Oils of Piper nigrum L .Intel J Bio Med Res. 2010;1(4):215–218.
17. Ternes, W.; Krause, E. L. Characterization and Determination of Piperine and PiperineIsomers in Eggs. Anal. Bioanal. Chem.2002;374(1);155-160.
18. Dang QT, Phan N. Optimization of Supercritical CO 2 Extraction of Oleoresin From Black Pepper (Piper nigrum L .) and Antioxidant Capacity of the Oleoresin. Int Food Res J. 2014;21(4):1489–1493.
19. Hikmayanti NPE, Hariyanti, Aulia C, Viransa VP. Kandungan Piperin Dalam Ekstrak Buah Lada Hitam dan BuahLada Putih (Piper nigrum.L) yang Diekstraksi dengan Variasi Konsentrasi Etanol Menggunakan Metode KLT-Densitometri. Media Farm. 2016;13(2):173–185.
20. Febriyanti AP, Iswarin SJ, Susanti. Penetapan Kadar Piperin dalam Ekstrak Buah Lada Hitam (Piper nigrum Linn.) Menggunakan Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS). J Ilm Farm Farmasyifa. 2016;1(2):69–79.
21. Singh G, Marimuthu P, Catalan CA, deLampasona MP. Chemical, Antioxidant and Antifungal Activities of Volatile Oil of Black Pepper and its Acetone Extract. J Sci Food

Agriculture. 2004;1878–1884.

22. Gorgani L, Mohammadi M, Najafpour GD, Nikzad M. Piperine — The Bioactive Compound of Black Pepper : From Isolation to Medicinal Formulations. Compr Rev inFood Sci Food Saf. 2017;16:129–140.
23. Molyneux P. The Use of the Stable Free Radical Diphenylpicryl- hydrazyl (DPPH) for Estimating Antioxidant Activity. Songklanakarin J Sci Technol. 2004;26(2):211–219.
24. Heim KE, Tagliaferro AR, Bobilya DJ. Flavonoid Antioxidants : Chemistry, Metabolism Flavonoid Antioxidants : Chemistry, Metabolism and Structure-Activity Relationships. The Journal Nutr Biochem. 2002;13:572–584.
25. Sapam R, Kalita PP, Sarma MP, Talukdar N, Das H. Screening of Phytochemicals and Determination of Total Phenolic Content, Antioxidant and Antimicrobial Activity of Methanolic Extract of Piper Nigrum Leaves. Indo Am J Pharm Res. 2018;8(2).1354-1360. Available from: https://www.researchgate.net/publication/323613522.
26. Eleazu CO, Eleazu KC, Awa E, Chukwuma SC. Comparative Study of the Phytochemical Composition of the Leaves of Five Nigerian Medicinal Plants. J Biotechnol Pharm Res. 2012;3(2):42–46.
27. Ekaputri TW, Kanedi M, Sutyarso, Busman H. Effect Of Black Pepper (Piper nigrum L.) Extract On Male Mice (Mus musculus L.) Libido Of Different Age. j Biologi Eksperimen dan Keanekaragaman Hayati. 2014;2(1):1–5.
28. D'Cruz SC, Mathur PP. Effect of Piperine on the Epididymis of Adult Male Rats. Asian J Androl. 2005;7(4):363–368. Available from:
29. https://www.researchgate.net/publication/7487318 Effect.
30. Hull EM, Muschamp JW, Sato S. Dopamine and Serotonin : Influences on Male Sexual Behavior. J Physiology & Behavior. 2004;291–307.
31. Kanedi M, Rosa E. Effects of Black Pepper (Piper nigrum Linn .) Extract on Sexual Drive in Male Mice. Res Journal of Medical Plant. 2015;9(1):42-47. [32] Hartati, Pagarra H. Differences of Ethanol Extract and Ethyl Acetate of Pepper Leaf (Piper Nigrum L) Against Anti Microbial Activity. Jurnal Sainsmat. 2018; VII(1):1–7.
32. Kadam P., Yadav KN, Patel FA., Karjikar, Patil MJ. Pharmacognostic, Phytochemical and Physicochemical Studies of Piper nigrum Linn. Fruit (Piperaceae). Int Res J Pharm. 2013;4(5). 189-193.
33. Zou L, Hu YY, Chen WX. Antibacterial Mechanism and Activities of Black Pepper Chloroform Extract. J Food Csi Technol. 2015:1-8.
34. Mishra A, Punia JK, Bladen C, Zamponi GW, Mishra A, Punia JK, Zamponi GW, Goel

RK. Anticonvulsant Mechanisms of Piperine, a Piperidine Alkaloid. Taylor & Francis Group. 2015;317-323.

35. Shamkuwar PB, Shahi SR, Jadhav ST. Evaluation of Antidiarrhoeal Effect of Black Pepper (Piper nigrum L.). Pelagia Research Library. 2012;2(1):48–53.
36. Capasso R, Izzo AA, Borrelli F, Russo A, Sautebin L, Pinto A, Capasso F, Mascolo N. Effect of Piperine, the Active Ingredient of Black Pepper, on Intestinal Secretion in Mice. Life Sciences. 2002;71:2311–2317.