REVIEW ARTICLE

A Review on Phytopharmacological Profile of *Illicium verum* Hook. F

Shazia Mulla*[1], Santosh B Patil[2]

[1] *Research Scholar, Department of Pharmacology, KLE College of Pharmacy, Hubballi, Karnataka, India*
[2] *Assistant Professor, Department of Pharmacology, KLE College of Pharmacy, Hubballi, Karnataka, India*

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Abstract: Star anise (*Illicium verum* Hook. f.), an aromatic evergreen tree of the Schisandraceae family, has served as both a culinary spice and medicinal herb in traditional Chinese and Indian medicine systems. The star-shaped fruits of *I. verum* contain a diverse array of bioactive compounds, including phenylpropanoids, terpenoids, flavonoids, lignans, and essential oils. Among these, trans-anethole stands out as the predominant phytochemical, comprising 72-92% of the fruit's essential oil composition. Modern pharmacological studies have validated numerous therapeutic properties of *I. verum*, including antioxidant, antimicrobial, anti-inflammatory, anticancer, and neuroprotective effects. The plant demonstrates significant potential in managing diabetes, obesity, and cardiovascular disorders through its hypoglycemic and hypolipidemic activities. Its hepatoprotective and renal protective properties stem from potent antioxidant mechanisms, while its anti-inflammatory effects operate primarily through NF-κB pathway inhibition. The presence of shikimic acid, a crucial precursor in antiviral drug synthesis, further enhances its pharmaceutical significance. Recent investigations have revealed promising anti-osteoporotic effects through enhanced vascularization and bone density improvement. While preliminary safety studies indicate low toxicity, additional clinical trials are essential to establish optimal dosing, efficacy parameters, and potential drug interactions. This review discusses about the current scientific evidence on *I. verum*'s botanical characteristics, phytochemical composition, pharmacological activities, and safety profile.

Keywords: *Illicium verum*; Anethole; Anti-diabetic; Hypolipidemic; Anti-Cancer activity.

1. Introduction

Illicium verum Hook. f., commonly known as star anise, represents a significant medicinal plant with deep roots in traditional healing systems. The plant's name derives from the Latin word "illicere," meaning "to allure," reflecting the captivating aromatic properties of its aerial parts [1]. Native to southeastern China and Vietnam, *I. verum* cultivation has expanded globally to meet increasing demand, with significant production in Morocco, India, the Philippines, Europe, Cambodia, Myanmar, Mexico, and Indonesia [2]. In Chinese traditional medicine, *I. verum* holds a unique position as both a culinary spice and therapeutic agent. The Chinese Ministry of Health classifies it under the "both food and medicine" category, acknowledging its minimal toxicity profile and safe consumption history [3]. The medicinal applications of star anise extend beyond Chinese medicine into various traditional healing systems, particularly in treating respiratory conditions, digestive disorders, and rheumatic ailments [4]. The therapeutic versatility of *I. verum* stems from its rich phytochemical composition.

Figure 1. Fruit of *Illicium verum* Hook. f

* Corresponding author: Shazia Mulla

The plant synthesizes an array of bioactive compounds, including phenylpropanoids, terpenoids, alkaloids, flavonoids, and essential oils [5]. Trans-anethole, the principal bioactive compound, contributes significantly to the plant's pharmacological effects, demonstrating anti-inflammatory, antioxidant, and antimicrobial properties [6]. Additionally, the presence of shikimic acid, a key precursor in antiviral drug synthesis, has elevated its importance in modern pharmaceutical research [7].

Table 1. Traditional Medicinal Uses of *Illicium verum* Hook. f. Across Different Cultural Systems

Traditional System	Medical Applications	Parts Used	Mode of Administration
Chinese Medicine	Digestive disorders	Fruits	Decoction, powder
	Respiratory infections	Seeds	Tea infusion
	Abdominal pain	Essential oil	Topical application
	Vomiting	Dried fruits	Oral consumption
Indian Medicine	Rheumatoid arthritis	Fruits	Decoction
	Asthma	Essential oil	Inhalation
	Dysentery	Seeds	Powder form
	Nervous disorders	Dried fruits	Tea preparation
Vietnamese Medicine	Infant colic	Fruits	Infusion
	Joint pain	Essential oil	External application
	Digestive ailments	Seeds	Oral consumption
European Traditional Medicine	Bronchitis	Dried fruits	Tea, tincture
	Flatulence	Essential oil	Aromatherapy
	Menstrual pain	Seeds	Oral preparation

Recent scientific investigations have validated many traditional uses of *I. verum* through rigorous pharmacological studies. The plant exhibits multiple biological activities, including anticancer, antidiabetic, hepatoprotective, and neuroprotective effects [8]. These properties arise from complex interactions between its various phytochemical constituents, often producing synergistic therapeutic effects [9].

2. Botanical Description and Taxonomy

2.1. Taxonomic Classification

Under modern botanical classification, following the Angiosperm Phylogeny Group IV system (2016), *I. verum* is placed within the Schisandraceae family, although historically it was classified under Illiciaceae [10]. The taxonomic hierarchy places it in the order Austrobaileyales, reflecting its evolutionary relationships with other primitive flowering plants [11].

2.2. Morphological Characteristics

I. verum manifests as an evergreen tree reaching heights of 8-15 meters, with a trunk diameter of approximately 25 centimeters. The plant exhibits distinct morphological features across its various parts:

2.2.1. Vegetative Features

The leaves display a characteristic lanceolate to obovate-elliptic shape, measuring 6-12 centimeters in length. Their light green coloration and leathery texture serve as key identifying features [12]. The bark presents a distinctive white to light gray coloration, contributing to the plant's recognition in its natural habitat.

2.2.2. Reproductive Structures

The flowers emerge either solitarily or in small clusters at axillary or terminal positions. Each bisexual flower features 7-12 tepals, measuring 9-12 millimeters in length and 8-12 millimeters in width. The flowers exhibit a pink to greenish coloration and contain distinctive glandular spots [13].

2.2.3. Fruit Characteristics

The most recognizable feature of *I. verum* is its star-shaped fruit, measuring 35-40 millimeters in diameter. Each fruit comprises 6-10 follicles arranged radially, containing smooth, ovoid brown seeds. The fruit stalks measure 20-56 millimeters in length, and the entire structure emits the characteristic anise aroma that gives the plant its common name [14]

3. Phytochemical Composition

3.1. Major Chemical Constituents

I. verum produces over 200 distinct chemical compounds, distributed across multiple phytochemical classes. The bioactive constituents present in star anise contribute synergistically to its therapeutic properties. The major phytochemical groups include phenylpropanoids, terpenoids, flavonoids, and essential oils [15].

3.1.1. Phenylpropanoids

Trans-anethole represents the most abundant phenylpropanoid in *I. verum*, constituting 72-92% of the essential oil content. Other significant phenylpropanoids include estragole (methyl chavicol) and cis-anethole. These compounds contribute primarily to the plant's aromatic properties and therapeutic effects [16].

3.1.2. Terpenoids and Essential Oils

The monoterpenoid profile includes α-pinene, p-cymene, eugenol, linalool, and various terpineol derivatives. Sesquiterpenoids present in significant quantities include trans-α-bergamotene, α-copaene, and several caryophyllene variants. These compounds play crucial roles in the plant's antimicrobial and anti-inflammatory activities [17].

3.1.3. Flavonoids and Phenolic Compounds

I. verum contains several bioactive flavonoids, including kaempferol, quercetin, isorhamnetin, and rutin. These compounds, along with phenolic acids such as gallic acid and p-hydroxybenzoic acid, contribute significantly to the plant's antioxidant properties [18].

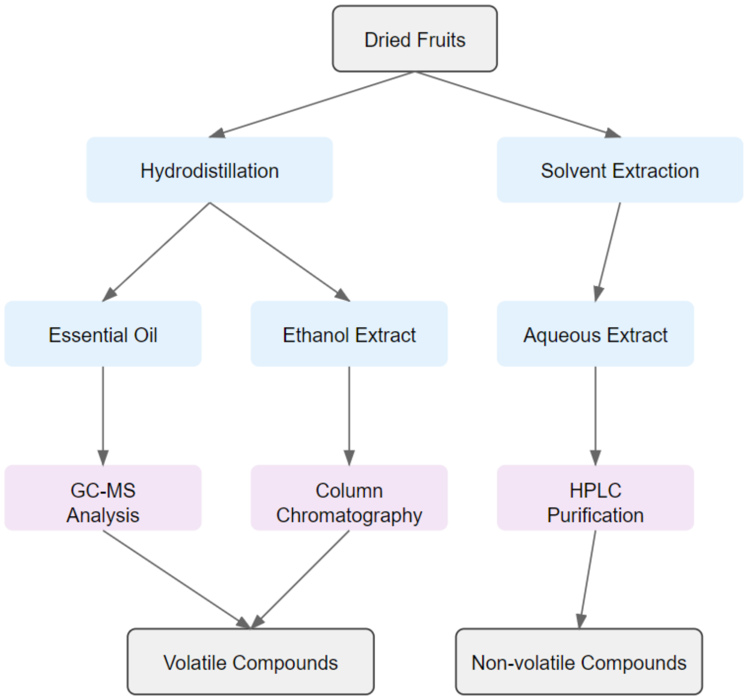

Figure 2. Extraction and Isolation Process of Bioactive Compounds from *I. verum*

3.2. Secondary Metabolites

The plant produces various secondary metabolites, including organic acids, fatty acids, and unique compounds specific to the Illicium genus. Shikimic acid, a crucial precursor in pharmaceutical synthesis, represents one of the most significant organic acids present [19].

Table 2. Phytochemical Analysis of *Illicium verum* Essential Oil

Compound Class	Component	Percentage (%)	Biological Activity
Phenylpropanoids	trans-Anethole	72-92	Antimicrobial, anti-inflammatory
	Estragole	2-6	Antioxidant
	cis-Anethole	0.2-0.4	Flavoring agent
Monoterpenes	Limonene	2.4-4.2	Anticancer
	α-Pinene	1.2-2.5	Anti-inflammatory
	β-Pinene	0.2-0.6	Antimicrobial
	Linalool	0.3-1.2	Anxiolytic
Sesquiterpenes	α-Copaene	0.1-0.3	Antioxidant
	β-Caryophyllene	0.2-0.5	Anti-inflammatory
	α-Terpineol	0.1-0.4	Antimicrobial
Others	p-Anisaldehyde	0.2-0.8	Flavoring agent
	Safrol	0.1-0.3	Antimicrobial

4. Pharmacological Activities

4.1. Antioxidant Properties

I. verum exhibits potent antioxidant activity through multiple mechanisms. The phytoconstituents effectively scavenge free radicals, as demonstrated through DPPH, ABTS, and hydroxyl radical assays. The antioxidant effects arise from the synergistic action of polyphenols, flavonoids, and phenylpropanoids, particularly trans-anethole. These compounds protect against oxidative stress-induced cellular damage, potentially preventing various chronic diseases [20].

4.2. Antimicrobial Activities

4.2.1. Antibacterial Effects

The antibacterial properties of *I. verum* manifest through multiple mechanisms. Trans-anethole disrupts bacterial cell membrane integrity and impairs respiratory chain function. The plant shows greater efficacy against gram-positive bacteria compared to gram-negative organisms, attributed to structural differences in bacterial cell walls [21].

4.2.2. Antifungal Properties

Star anise demonstrates significant antifungal activity through its essential oil components. The plant's constituents maintain cell wall integrity and create barriers against fungal pathogens. Additionally, its anti-aflatoxigenic properties influence key biosynthetic pathways, inhibiting mycotoxin production [22].

Table 3. Pharmacological Activities of *I. verum* Extract/Compounds with Their Mechanisms of Action

Activity	Active Compound(s)	Mechanism of Action	Study Model
Antidiabetic	Trans-anethole, Polyphenols	Inhibition of α-glucosidase Enhanced insulin sensitivity Reduced AGE formation	*In vivo* (rat model) STZ-induced diabetes
Anticancer	Anethole, Flavonoids	Apoptosis induction Cell cycle arrest NF-κB pathway inhibition	MCF-7 cells MDA-MB-231 cells
Hepatoprotective	Flavonoids, Phenolics	Antioxidant activity Reduced inflammation Membrane stabilization	CCl_4-induced hepatotoxicity
Neuroprotective	Quercetin, Kaempferol	Cholinesterase inhibition Antioxidant effects Reduced neuroinflammation	Scopolamine-induced memory impairment

4.3. Gastrointestinal Effects

4.3.1. Anti-ulcer Properties

I. verum exhibits gastroprotective effects against ethanol-induced ulcers. The mechanism involves enhanced antioxidant enzyme activity, including catalase and superoxide dismutase, while simultaneously reducing lipid peroxidation. Phenolic compounds play a central role in this protective action [23].

4.3.2. Antidiarrheal Activity

The plant's antidiarrheal properties stem from specific coumarin derivatives, particularly 7-hydroxycoumarin and 7-methoxycoumarin. These compounds, along with dicycloether and anethole, modulate intestinal motility and provide anti-spasmodic effects [24].

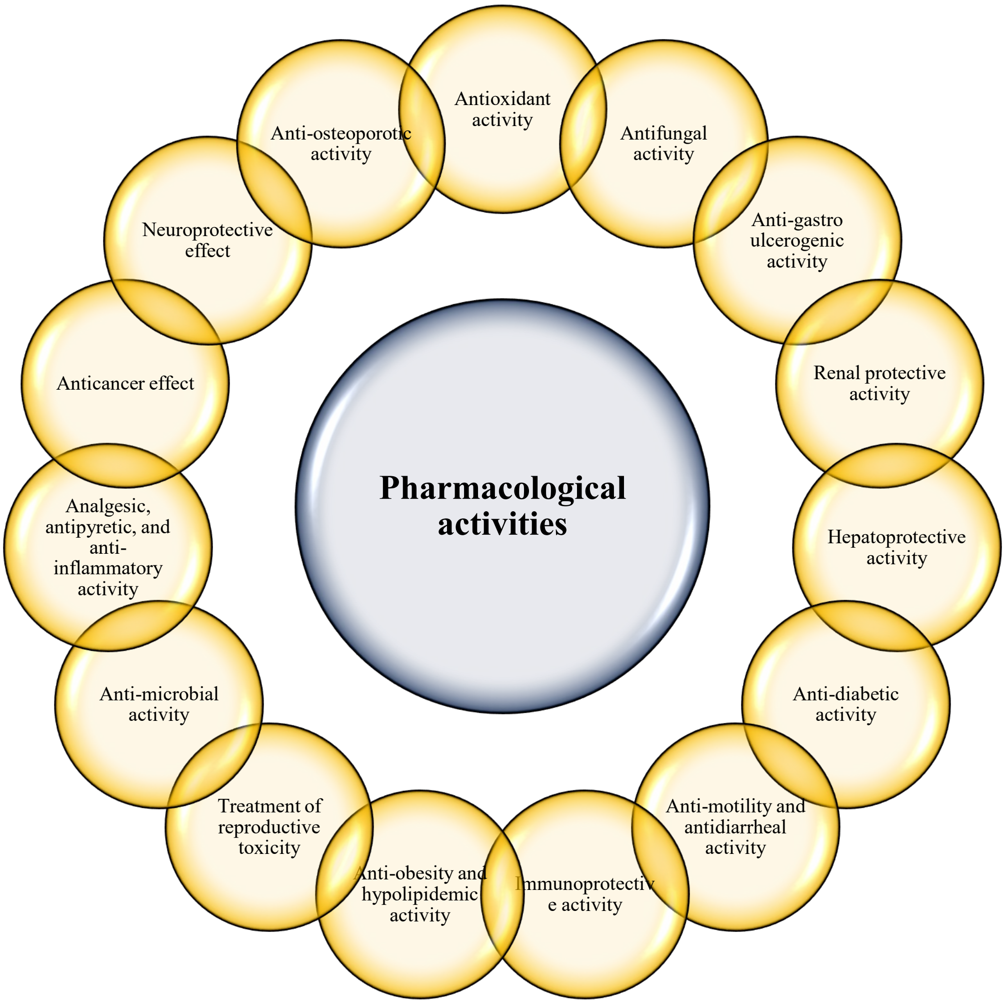

Figure 3. Pharmacological activities of *Illicium verum* Hook. f.

4.4. Metabolic and Endocrine Effects

4.4.1. Antidiabetic Activity

I. verum demonstrates significant antidiabetic properties through multiple mechanisms. The plant inhibits the formation of Advanced Glycation End products (AGEs), crucial mediators of diabetic complications. Trans-anethole modulates key metabolic enzymes, including hexokinase, glucose-6-phosphate dehydrogenase, and fructose-1,6-bisphosphatase in hepatic and renal tissues. The polyphenolic compounds enhance insulin sensitivity and regulate insulin secretion, contributing to glycemic control [25].

4.4.2. Anti-obesity and Lipid-lowering Effects

Star anise exhibits potent anti-obesity properties through regulation of adipocyte metabolism. The flavonoids and polyphenols present in *I. verum* inhibit pancreatic lipase activity and stimulate thermogenesis. The plant improves lipid profiles by modulating

LDL receptor activity and reducing cholesterol synthesis. These effects have been validated in high-fat-diet induced obesity models [26].

4.5. Protective Effects on Vital Organs

4.5.1. Hepatoprotective Activity

I. verum demonstrates liver-protective effects through multiple mechanisms. The plant's constituents, particularly flavonoids and anethole, reduce membrane peroxidation and enzyme leakage. The hepatoprotective action involves anti-inflammatory pathways, evidenced by decreased IL-6 and TNF-α production. Additionally, the plant exhibits anti-fibrotic and liver-regenerating properties in CCl4-induced hepatotoxicity models [27].

4.5.2. Renal Protective Effects

Star anise protects against kidney toxicity, particularly in cases of chemotherapy-induced nephrotoxicity. The phenolic compounds neutralize oxidative stress and maintain renal function by preserving cellular integrity. The plant's antioxidant properties play a crucial role in preventing renal tissue damage [28].

4.6. Immunomodulatory and Anti-inflammatory Properties

4.6.1. Immune System Modulation

I. verum exhibits significant immunoprotective effects, particularly against benzopyrene-induced immunotoxicity. The plant helps maintain normal leukocyte counts and modulates platelet function. These effects contribute to balanced hematological parameters during immune system disruptions [29].

4.6.2. Anti-inflammatory Mechanisms

The anti-inflammatory activity of star anise operates through multiple pathways. The plant inhibits pro-inflammatory mediators, including IL-1, TNF-α, and prostaglandin E2. Anethole specifically blocks inflammatory cytokine production in various cell types. The flavonoid components suppress eicosanoid synthesis and neutrophil degranulation, while primarily modulating the NF-κB pathway [30].

4.7. Anticancer Properties

I. verum demonstrates antiproliferative and pro-apoptotic effects against various cancer cell lines. Studies on breast cancer cells (MCF-7 and MDA-MB-231) have shown significant cytotoxic activity. The anticancer properties stem from multiple mechanisms, including cell cycle arrest, apoptosis induction, and anti-inflammatory effects. Anethole plays a central role in these anticancer activities [31].

4.8. Neuroprotective Effects

Star anise exhibits significant neuroprotective properties through various mechanisms. The plant demonstrates anti-amnesic effects and cholinesterase inhibitory activity, as evidenced in radial arm maze studies. The antioxidant compounds present in *I. verum* reduce oxidative stress-induced neuronal damage. Flavonoids, particularly quercetin and kaempferol, positively influence central nervous system function [32].

4.9. Effects on Bone Health

4.9.1. Anti-osteoporotic Activity

I. verum demonstrates significant effects on bone health, particularly in osteoporotic conditions. The plant enhances vascularization in osteoporotic fractures by elevating serum levels of nitric oxide and vascular endothelial growth factor (VEGF). At the molecular level, star anise increases the expression of key proteins involved in angiogenesis, including eNOS, Cyclin D1, VEGF, and HIF-1α. The plant simultaneously suppresses oxidative stress-related enzymes NOX_2 and NOX_4, while promoting endothelial cell migration and proliferation [33].

4.9.2. Bone Regeneration Properties

The bone regenerative properties of *I. verum* manifest through improved femoral bone density and enhanced maximal load capacity. The plant promotes the formation and growth of new blood vessels in fracture callus, facilitating bone healing. These effects are mediated through the PI3K/Akt signaling pathway and regulation of angiogenic factors [34].

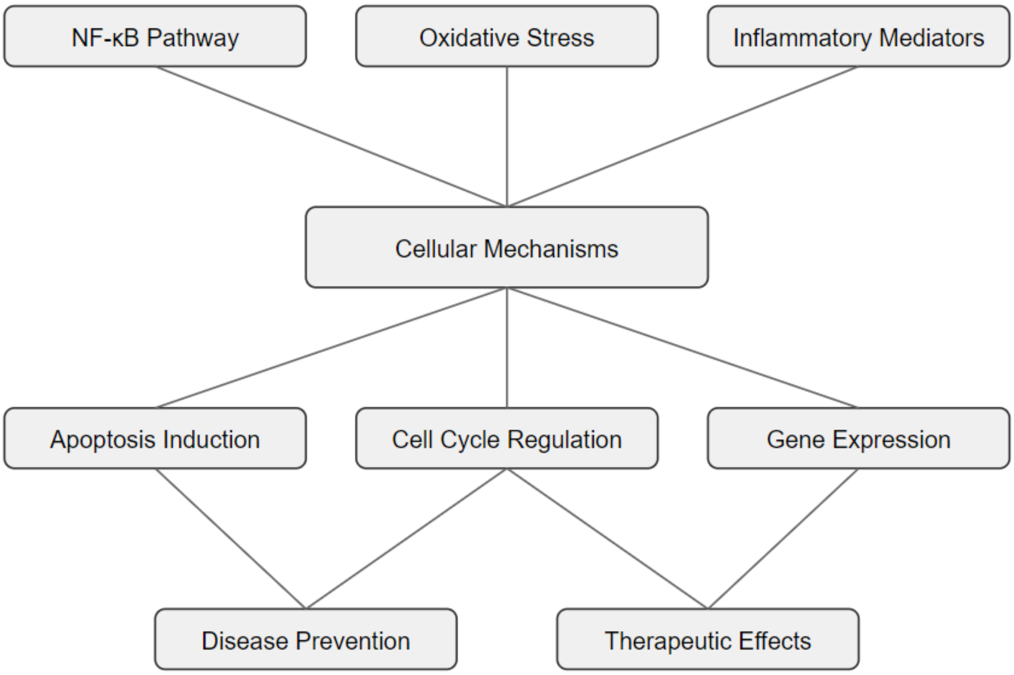

Figure 4. Molecular Mechanisms of Action of *I. verum*'s Major Bioactive Compounds

5. Safety and Toxicity

5.1. General Safety Assessment

While *I. verum* enjoys widespread use as a culinary spice, indicating general safety for human consumption, systematic toxicological evaluation remains crucial. Acute oral toxicity studies in preclinical models have established safety up to doses of 2000 mg/kg body weight [35].

5.2. Toxicity

5.2.1. Acute and Chronic Toxicity

Long-term safety studies have shown minimal adverse effects when star anise is consumed within recommended doses. However, monitoring is essential as natural products may still present risks despite their traditional use history [36].

5.2.2. Drug Interactions and Contraindications

Limited data exists regarding potential interactions between *I. verum* and conventional medications. Healthcare providers should exercise caution when recommending star anise alongside other therapeutic agents, particularly those metabolized through similar pathways [37].

Table 4. Clinical Safety and Toxicity Profile of *I. verum*

Parameter	**Observation**	**Safety Limit**	**Comments**
Acute Oral Toxicity	Safe up to 2000 mg/kg	LD50 > 2000 mg/kg	Preclinical studies
Chronic Administration	Well-tolerated	Up to 400 mg/kg/day	90-day study
Essential Oil Safety	Moderate caution	0.1-1% dilution	Topical use
Drug Interactions	Limited data	Not established	Further studies needed
Contraindications	Pregnancy	Avoid therapeutic doses	Traditional warning
Maximum Daily Intake	1-3 g dried fruit	5 g/day maximum	Traditional dosing
Hepatotoxicity	None reported at normal doses	Within recommended limits	Regular monitoring advised
Allergic Reactions	Rare cases reported	Individual sensitivity	Patch test recommended

6. Conclusion

Star anise has rich phytochemical profile, particularly its high trans-anethole content, that contributes to its numerous pharmacological activities. It has significant potential in managing various conditions, including diabetes, cancer, neurodegenerative disorders, and bone diseases. The established safety profile supports its traditional use, though further clinical studies are necessary to optimize its therapeutic applications. Modern research should focus on clinical validation, mechanism elucidation, and safety profiling to fully realize the therapeutic potential of *I. verum*.

References

[1] Wang GW, Hu WT, Huang BK, Qin LP. *Illicium verum*: a review on its botany, traditional use, chemistry and pharmacology. J Ethnopharmacol. 2011;136(1):10-20.

[2] Fritz E, Ölzant SM, Länger R. *Illicium verum* Hook. f. and Illicium anisatum L.: anatomical characters and their value for differentiation. Sci Pharm. 2008;76(1):65-76.

[3] Wei L, Hua R, Li M, Huang Y, Li S, He Y, et al. Chemical composition and biological activity of star anise *Illicium verum* extracts against maize weevil, Sitophilus zeamais adults. J Insect Sci. 2014;14:80.

[4] Chouksey D, Upmanyu N, Pawar RS. Central nervous system activity of *Illicium verum* fruit extracts. Asian Pac J Trop Med. 2013;6(11):869-75.

[5] Patra JK, Das G, Bose S, Banerjee S, Vishnuprasad CN, del Pilar Rodriguez-Torres M, et al. Star anise (*Illicium verum*): Chemical compounds, antiviral properties, and clinical relevance. Phytother Res. 2020;34(6):1248-67.

[6] Huang Y, Zhao J, Zhou L, Wang J, Gong Y, Chen X, et al. Antifungal activity of the essential oil of *Illicium verum* fruit and its main component trans-anethole. Molecules. 2010;15(11):7558-69.

[7] Wang F, Jiang YY, Wang XL, Wang ZM, Li JY, Xia YF, et al. Chemical constituents and bioactivities of *Illicium verum*. Chin J Nat Med. 2011;9(2):125-30.

[8] Padmashree A, Roopa N, Semwal AD, Sharma GK, Agathian G, Bawa AS. Star anise (*Illicium verum*) and black caraway (Carum nigrum) as natural antioxidants. Food Chem. 2007;104(1):59-66.

[9] Yang JF, Yang CH, Chang HW, Yang CS, Wang SM, Hsieh MC, et al. Chemical composition and antibacterial activities of *Illicium verum* against antibiotic-resistant pathogens. J Med Food. 2010;13(5):1254-62.

[10] De Carvalho PM, Rodrigues RF, Sawaya AC, Marques MO, Shimizu MT. Chemical composition and antimicrobial activity of the essential oil of *Illicium verum* Hook. f. Rev Bras Farmacogn. 2010;20(5):718-23.

[11] Koch A, Tamez P, Pezzuto J, Soejarto D. Evaluation of plants used for antimalarial treatment by the Maasai of Kenya. J Ethnopharmacol. 2005;101(1-3):95-9.

[12] Liu X, Chen Q, Wang Z, Xie L, Xu Z. Allelopathic effects of essential oil from *Illicium verum* Hook. f. and its main component on garlic sprout growth. Food Chem. 2008;108(4):1200-4.

[13] Zou Y, Lu Y, Wei D. Antioxidant activity of a flavonoid-rich extract of Hypericum perforatum L. *in vitro*. J Agric Food Chem. 2004;52(16):5032-9.

[14] Aly SE, Sabry BA, Shaheen MS, Hathout AS. Assessment of antimycotoxigenic and antioxidant activity of star anise (*Illicium verum*) *in vitro*. J Saudi Soc Agric Sci. 2016;15(1):20-7.

[15] Sharafan M, Jafernik K, Ekiert H, Kubica P, Kocjan R, Blicharska E, et al. *Illicium verum* (star anise) and trans-anethole as valuable raw materials for medicinal and cosmetic applications. Molecules. 2022;27(3):650.

[16] Sung YY, Kim YS, Kim HK. *Illicium verum* extract inhibits TNF-α-and IFN-γ-induced expression of chemokines and cytokines in human keratinocytes. J Ethnopharmacol. 2012;144(1):182-9.

[17] Dzamic A, Sokovic M, Ristic MS, Grijic-Jovanovic S, Vukojevic J, Marin PD. Chemical composition and antifungal activity of *Illicium verum* and Eugenia caryophyllata essential oils. Chem Nat Compd. 2009;45:259-61.

[18] Dinesha R, Thammannagowda SS, Prabhu MS, Madhu CS, Srinivas L. The antioxidant and DNA protectant activities of Star Anise (*Illicium verum*) aqueous extracts. J Pharmacogn Phytochem. 2014;2(5):98-103.

[19] Kumar R, Sharma S, Sharma S, Kumar N. Chemical composition and bioactivities of essential oils of *Illicium verum* Hook. f. and Allium sativum Linn. J Pharmacogn Phytochem. 2019;8(1):1171-80.

[20] Iftikhar N, Hussain AI, Kamal GM, Manzoor S, Fatima T, Alswailmi FK, et al. Antioxidant, anti-obesity, and hypolipidemic effects of polyphenol rich Star Anise (*Illicium verum*) tea in high-fat-sugar diet-induced obesity rat model. Antioxidants. 2022;11(11):2240.

[21] Khan S, Bhatti HA, Abbas G, Versiani MA, Faizi S, Ahmed SK, et al. *Illicium verum* extract exhibited anti-inflammatory action in rodents. Lett Drug Des Discov. 2018;15(6):678-86.

[22] Wei J, Zhang X, Bi Y, Miao R, Zhang Z, Su H. Anti-inflammatory effects of cumin essential oil by blocking JNK, ERK, and NF-κB signaling pathways in LPS-stimulated RAW 264.7 cells. Evid Based Complement Alternat Med. 2015;2015:474509.

[23] Ibrahim FM, Ibrahim AY, Abdel-Gawad MM, Hussein MS, Ahmed KA. *Illicium verum* extracts anti-gastro ulcerogenic potential on experimentally rat models. Int J Pharm Sci. 2016;9(5):65-80.

[24] Díaz A, Vargas-Perez I, Aguilar-Cruz L, Calva-Rodriguez R, Treviño S, Venegas B, et al. A mixture of chamomile and star anise has anti-motility and antidiarrheal activities in mice. Rev Bras Farmacogn. 2014;24:419-24.

[25] Khan HN, Rasheed S, Choudhary MI, Ahmed N, Adem A. Anti-glycation properties of *Illicium verum* Hook. f. fruit *in-vitro* and in a diabetic rat model. BMC Complement Med Ther. 2022;22(1):79.

[26] Singh S, Verma R. Comprehensive review on pharmacological potential of *Illicium verum*, Chinese herb. Pharmacol Res Mod Chin Med. 2024;100411.

[27] Ismail EA, Nafie E, Farid AS. Star Anise (*Illicium verum*) oil administration alleviates carbon tetrachloride-induced hepatotoxicity in rats. Int J Vet Sci. 2020;39:100-4.

[28] Al-Ameri AS. Prevention of Etoposide induced kidney toxicity, electrolytes, injury and KI67 alternations in male rats treated with star anise. J Biosci Appl Res. 2017;3(2):36-41.

[29] Saleh EN, Saeed IA. Star Anise Reverses Benzopyrene-Induced Immune Dysfunction in Rats. Academia Open. 2024;9(2):10-21070.

[30] Majali IS. Antioxidant and anti-inflammatory activity of star anise (*Illicium verum*) in murine model. Biomed Pharmacol J. 2022;15(2):1097-108.

[31] Pahore AK, Khan S, Karim N. Anticancer effect of *Illicium verum* (star anise fruit) against human breast cancer MCF-7 cell line. Pak J Med Sci. 2023;39(1):70-4.

[32] Sayyar HT, Raza ML, Baqir SR. Evaluation of Antiamnesic and Cholinesterase inhibitory effects of *Illicium verum* hook.f (Star anise) against Scopolamine induced memory impairment in Mice. J Bahria Univ Med Dent Coll. 2022;13(01):8-12.

[33] Wu J, Li X, Liang Y, Xiao Z, Su H. Protective Effect of *Illicium verum* Extract On Vascularization In Rats With Osteoporotic Fracture. Altern Ther Health Med. 2024;30(8).

[34] Zhang WL, Chen JP, Lam KYC, Zhan JYX, Yao P, Dong TTX, et al. Hydrolysis of glycosidic flavonoids during the preparation of Danggui Buxue Tang: an outcome of moderate boiling of Chinese herbal mixture. Molecules. 2014;19(12):21560-76.

[35] Fritz E, Ölzant SM, Länger R. *Illicium verum* Hook. f. and Illicium anisatum L.: anatomical characters and their value for differentiation. Sci Pharm. 2008;76(1):65-76.

[36] Nakamura T, Okuyama E, Yamazaki M. Neurotropic components from star anise (*Illicium verum* Hook. fil.). Chem Pharm Bull. 1996;44(10):1908-14.

[37] Zou Q, Huang Y, Zhang W, Lu C, Yuan J. A comprehensive review of the pharmacology, chemistry, traditional uses and quality control of star anise (*Illicium verum* Hook. F.): An aromatic medicinal plant. Molecules. 2023;28(21):7378