

“BEYOND FLAVOR: THE ROLE OF GINGER (*ZINGIBER OFFICINALE*) IN HUMAN HEALTH AND DISEASE PREVENTION”

Shaik Adeena Parveen^{1*}, Uzair Yousf Mir¹, Rayees Ahmad Mir¹, Mohd. Nayab², Abdul Azeez² and Abdul Nasir Ansari³

PG Scholar¹, Associate Professor², Professor and Head³,
Department of Regimenal Therapies, National Institute of Unani Medicine, Bangalore, India.



*Corresponding Author: Shaik Adeena Parveen

PG Scholar, Department of Regimenal Therapies, National Institute of Unani Medicine, Bangalore, India.

Article Received on 02/12/2024

Article Revised on 23/12/2024

Article Accepted on 12/01/2025

ABSTRACT

Ginger (*Zingiber officinale* Roscoe) is one of the most popular spices worldwide known not only for its taste but also for its therapeutic properties. When fresh, it's known as *Adrak* (*Zanjabeel-e-Ratab*), and when dried, it's called *Sonth* (*Zanjabeel-e-Yabis*). Ginger is a widely used medicinal plant known for its rich profile of bioactive compounds, including gingerols, shogaols, and paradols. This review explores ginger's diverse pharmacological properties, including its antioxidant, anti-inflammatory, antimicrobial, anticancer, and antihypertensive effects, as demonstrated in in vitro and animal studies. These bioactivities are believed to contribute to ginger's traditional use in treating various ailments. Despite promising laboratory findings, limited clinical evidence exists to validate these effects in humans. This article emphasizes the need for further research, particularly well-designed clinical trials, to isolate and understand ginger's bioactive compounds and elucidate their mechanisms of action. Future studies may establish ginger's potential as a complementary therapeutic agent and broaden its applications in modern healthcare.

KEYWORDS: Ginger, *Adrak*, *Sonth*, *Zanjabeel*, Gingerols, Unani.

INTRODUCTION

Ginger (*Zingiber officinale* Roscoe) is one of the most popular spices worldwide and adds a distinctive, warm flavour to many foods and drinks. It is not only known for its taste but also for its health benefits.^[1] Ginger has traditionally been used to help with Digestive issues, Rheumatism, swelling, neuralgia and Diabetes. Its unique, strong aroma comes from compounds called ketones, especially gingerol, which has been the focus of many scientific studies.^[2] The part of ginger we consume is called the rhizome, often referred to as ginger root even though it isn't actually a root but a stem that grows underground. When fresh, it's known as *Adrak* (*Zanjabeel-e-Ratab*), and when dried, it's called *Sonth* (*Zanjabeel-e-Yabis*).^[3-5]

MATERIAL AND METHODS

The literature on Ginger was sourced from computerized databases, including PubMed, Google Scholar, Science Direct, and Scopus by searching keywords like Ginger, *Zingiber*, *Adrak*, *Sonth*, etc., We also explored classical texts of Unani medicine, such as *Khazain-Al-Advia*, *Muhit-i-Azam*, *Makhzan-Al-Mufradat*, *Qarabadin Najm-Al-Ghani*, *Bustan-Al-Mufradat*, *Qarabadin-i-A'zam*, and *Kitab Al-Fath fi Al-Tadawi*. Additionally, we consulted conventional botany references,

including *Flora Medica*, *Glossary of Indian Medicinal Plants*, *Indian Materia Medica*, *Indian Medicinal Plants*, *Handbook of Medicinal Herbs*, and *Compendium of Indian Medicinal Plants*. Our research encompassed both classical Unani literature and modern sources from digital databases.

Distribution

Ginger originally comes from the Indo-Malayan region but has spread across the globe as both a spice and a medicinal plant. Today, India leads the world in ginger production. Other major producers include countries like Australia, Brazil, Bangladesh, Cameroon, China, Costa Rica, Fiji, Ghana, Guatemala, Hawaii, Indonesia, Jamaica, Mauritius, Malaysia, Nepal, New Zealand, Nigeria, the Philippines, Sierra Leone, Sri Lanka, Taiwan, Thailand, Trinidad, and Uganda. Together, these countries cultivate ginger over a combined area of around 387,300 hectares, yielding approximately 1,476,900 metric tons. In India, ginger is primarily grown in Kerala, Andhra Pradesh, Uttar Pradesh, West Bengal, and Maharashtra.^[6]

Botanical Name - *Zingiber officinale* Roscoe.

Family – Zingiberaceae.

Scientific Classification

Kingdom - Plantae
 Subkingdom - Tracheobionata
 Subdivision - Spermatophyta
 Division - Magnoliophyta
 Class - Liliopsida
 Sub Class - Zingiberidae
 Order - Zingiberales
 Family - Zingibraceae
 Genus - Zingiber
 Species – officinale^[7]

VERNACULAR NAMES

Arabic: Zanjabeel, Qafeer

Bengali: Ada

China: Gan-Jiang (dried), Shēng jiāng (fresh)

Dutch: Gember

English: Ginger Root, Ginger

French: Gingembre

German: Ingwer

Greece: Zingiber, Piperoriza

Gujarati: Sunth, Sundh, Adu

Hindi: Sonth (dry), Adrak (fresh), Ada

Japan: Shouga

Kannada: Hasisunth, Ardraka, Sunthi

Kashmiri: Shoont

Latin: Zinziberi

Malyalam: Andrakam, Inchi

Marathi: Ardrak, Ale

Nepal: Agnimanth, Sutho

Persian: Sahangrez, Shangoweez, Zanjabil, Amveel

Punjabi: Adrak, Sonth

Russian: Imbir

Sanskrit: Ardrakam (fresh), Shunthi (dried), Shringaveran

Spanish: Jengibre

Tamil: Allam, inji

Telugu: Dried rhizome- Sonti, Fresh rhizome- Allam

Unani: Zanjebeel, Sonth, Hutiyoona

Urdu: Sonth, Zanjabeel, Adrak.^[8,9,10]

DESCRIPTION

Ginger is a tropical plant that thrives in hot, humid climates. There are three main varieties: giant or white ginger (*Zingiber officinale* var. *Roscoe*), small white ginger (*Zingiber officinale* var. *Amarum*), and red ginger (*Zingiber officinale* var. *Rubrum*). *Zingiber officinale* Roscoe, one of the most widely used herbs in Asia, has been traditionally used to address various health issues.

This perennial, herbaceous plant can reach about 100 cm in height, with leaves that sprout from its branching rhizome. The leaves are simple, alternate, and narrow, measuring about 2–3 cm across. They have a sheathing base and taper to a point. The plant's inflorescence forms on a single, lateral stem with cylindrical, spike-like clusters of flowers. Although rare, ginger's flowers resemble orchids, with overlapping scales on an elongated stalk and three yellow-orange petals along with a purplish, lip-like structure. The rhizomes are aromatic, thick, lobed, and pale yellow, and the plant produces multiple lateral shoots in clusters that start to dry out as the plant matures.^[11]

The rhizome of ginger is thick and tuberous, with upright leafy stems that reach a height of 0.6 to 1.2 meters. The rhizome itself typically measures 5 to 15 cm in length, 3 to 6 cm in width, and 0.5 to 1.5 cm in thickness. It has a flattened shape on the upper side and branches out into short, slightly flattened, oblique, obovate "fingers" or sections. Each of these branches is about 1 to 3 cm long and has a small, sunken scar at the tip, where the stem was once attached.^[12]



Figure: 1, 2 Fresh Ginger, Dry Ginger.

Parts Used -Root (Rhizome)**Therapeutic Actions (*Af'āl*)**

Zingiber officinale (ginger) is known for a variety of therapeutic properties:

- **Carminative** (*Muḥallil-e-Riyah*): Helps relieve gas and bloating.
- **Digestive Aid** (*Hazim*): Supports digestion.
- **Appetizer** (*Mushtahi Tu'am*): Stimulates appetite.
- **Liver and Stomach Tonic** (*Muqawwi-e-Mida-wa-Kabid*): Strengthens liver and stomach function.
- **Laxative** (*Mulayyin*): Relieves constipation.

- **Stimulant** (*Muharrik*): Boosts energy and vitality.
- **Sialagogue** (*Mudirr-e-Luab-e-Dehn*): Promotes saliva production.
- **Rubefacient** (*Muhammir*): Warms and soothes the skin.
- **Antilucer** (*Daf'-e-Qurooh*): Helps prevent ulcers.
- **Deobstruent for the Liver** (*Mufatteh Sudad-e-Jigar*): Clears obstructions in the liver.
- **Circulatory Stimulant**: Improves blood flow.
- **Aphrodisiac** (*Muqawwi-e-Bah*): Boosts libido.

- **Eye Tonic** (*Muqawwi-e-Basar*): Supports eye health.
- **Nervine Tonic** (*Muqawwi-e-A'shab*): Strengthens the nervous system.
- **Anti-inflammatory** (*Muḥallil-e-Warm*): Reduces inflammation.
- **Memory Enhancer** (*Muqawwi-e-Hafiza*): Improves memory.
- **Desiccant** (*Mujaffif-e-Ruṭūbat*): Dries up excess moisture in the body.
- **Expectorant** (*Munaffis-e-Balgham*): Clears mucus.
- **Phlegm-Clearing** (*Mushil-e-Balgham*): Helps expel phlegm.
- **Antiemetic** (*Daf'-e-Qai*): Relieves nausea.
- **Diaphoretic** (*Moa'rriq*): Promotes sweating.
- **Anthelmintic** (*Qatil-e-Dīdān*): Expels worms.
- **Spermatogenic** (*Muwallid-e-Mani*): Supports sperm production.
- **Brain Tonic** (*Muqawwi-e-Dimagh*): Enhances brain function.

In addition, ginger exhibits **antiplatelet**, **antibacterial**, and **antifungal** properties, making it beneficial for circulation and infection prevention.

Therapeutic uses (*Istemaal*)

Zingiber officinale (ginger) is traditionally used to treat a wide range of health issues, including:

- **Digestive Issues:** Indigestion (*Fasād al-Haḍm*), abdominal pain (*Dard-e-Shikam*), flatulence (*Nafkh*), and loss of appetite (*Za'f-e-Ishtihā*).
- **Eye and Ear Conditions:** Eye disorders (*Amrād-e-Ain*), ear problems (*Amrād-e-Uzn*), and ear pain (*Waja'al-Uzn*).
- **Joint and Muscular Pain:** Arthritis (*Wajaul mafasil*), ankylosing spondylitis (*Tahajjire mafasil*), gout (*Niqris*), and rheumatism (*Hudār*).
- **Fluid Retention:** Dropsy or edema (*Istisqā*).
- **Respiratory Issues:** Asthma (*Ḍiq al Nafas*), chest congestion (*Amrād-e-Sadar*), bronchitis (*Iltihāb al-Shu'ab*), dry cough (*Surfa*), and hoarseness of voice (*Bah't ul Sawt*).
- **Headaches and Migraines:** General headache (*Suda*) and migraines (*Shaqīqa*).
- **Colds and Catarrh:** Cold symptoms (*Nazla*).
- **Urinary Issues:** Urinary incontinence (*Taqīr-e-Bawl*).
- **Nervous System Disorders:** Paralysis (*Fali*), lower back pain (*Waja'al Qutn*), dementia (*Nisyān*), and facial palsy (*Laqwa*).
- **Skin and Hair Conditions:** Elephantiasis (*Da' al-Fīl*) and alopecia areata (*Da'us Salab*).
- **Liver and Blood Issues:** Jaundice (*Yaraqān*).
- **Female Health Concerns:** Leucorrhea (*Sailan-ur-Reham*) and amenorrhea (*Ihtibās-e-Ṭamth*).
- **Diabetes** (*Ziabetes*).
- **Nausea and Vomiting** (*Ghathayān*).

This versatile herb is valued for its use in treating digestive complaints, respiratory conditions, joint and muscle pain, skin issues, and more.^[13-24]

Pharmacological activity

Ginger is known for a wide range of pharmacological effects, including:

- **Antimicrobial:** Fights harmful bacteria and infections.
- **Anticonvulsant:** Helps manage seizures.
- **Analgesic:** Provides pain relief.
- **Anti-inflammatory:** Reduces inflammation.
- **Antiulcer:** Protects against ulcers.
- **Gastric Antisecretory:** Lowers stomach acid production.
- **Antidiabetic:** Supports blood sugar control.
- **Nephroprotective:** Protects kidney function.
- **Hepatoprotective:** Supports liver health.
- **Antitumor and Anticancer:** May help in cancer prevention and treatment.
- **Antispasmodic:** Relieves muscle spasms.
- **Antithrombotic:** Reduces blood clot formation.
- **Hypocholesterolemic:** Lowers cholesterol levels.
- **Antiallergic:** Helps manage allergy symptoms.
- **Antiserotonergic:** Modulates serotonin activity.
- **Anticholinergic:** Reduces overactivity in the nervous system.
- **Antioxidant:** Protects cells from damage.
- **Larvicidal:** Kills larvae, which can help prevent insect-borne diseases.
- **Immunomodulatory:** Boosts and balances the immune system.

These pharmacological properties make ginger valuable for a variety of health applications, from pain relief and inflammation control to protecting organs and supporting immune health.^[11]

Miqdār-e-khūrāk (Dose)

- **Powdered Ginger:** 1 to 1.5 grams, up to 7 grams per day if needed.
- **Fresh Ginger:** 3 to 10 grams, taken 1 to 3 times daily.²⁵
- **Dried Ginger:** 2 to 4 grams, taken 1 to 3 times daily.
- **General Use:** 1 to 2 grams daily,^{26,27} but can be increased to 7 grams if advised.^[9]

Muḥīr (Adverse effect)

- **Throat Problems** (*Amrād-e-Halaq*): It may irritate the throat in some cases.
- **Hot Temperament:** People with a naturally "hot" or fiery temperament might experience discomfort, as ginger can increase heat in the body.

These side effects are generally mild but should be considered, especially for those with sensitive conditions.

Musleh (Corrective)

Roghan-e-Badam (Almond oil - *Prunus amygdalus*) and Shahed (Honey).

Badal (Substitute)

Dar filfil (*Piper longum* Linn.)^[28], Aqarqarha (*Anacyclus pyrethrum* Linn.)^[9, 29]

Compound Unani Formulations

Habb-e-Hilteet,
Habb-e-Hindi Mohallil,
Habb-e-Hindi Zeeqi,
Habb-e-Kabid Naushadri,
Habb-e-Shifa,
Jawarish-e-Bisbasa,
Jawarish-e-Fanjnosh,
Jawarish-e-Jalinoos,
Jawarish-e-Kamooni,
Jawarish-e-Safarjali,
Jawarish-e-Shahreyaran,
Jawarish-e-Zanjabeel,
Luboob-e-Kabir,
Luboob-e-Saghir,
Majoon-e-Falasafa,
Majoon-e-Fanjnosh,
Majoon-e-Jograj Gugal,
Majoon-e-Seer Alvi Khan,
Majoon-e-Suparipak,
Majoon-e-Suranjan,
Murabba-e-Zanjabeel,
Roghan-e-Ispand,
Roghan-e-Jauzmasil,
Iyarij-e-Loghazia,
Sufoof-e-Hazim Kalan.^[16,17,18,19]

Drug Interaction

While there are few documented interactions between ginger and other drugs, one significant finding comes from a study in Taiwan. Researchers explored how ginger interacts with nifedipine, a medication used to treat hypertension, and its effects on platelet aggregation (blood clotting). The study revealed that hypertensive patients showed higher platelet aggregation compared to healthy individuals when exposed to substances like collagen, ADP, and epinephrine. Both aspirin and ginger were found to enhance nifedipine's ability to reduce platelet aggregation in both normal and hypertensive individuals. This suggests that ginger and nifedipine work together in a synergistic way to improve blood flow and reduce clotting. Based on these findings, combining 1 gram of ginger with 10 milligrams of nifedipine daily could be beneficial in reducing cardiovascular and cerebrovascular complications caused by excessive platelet aggregation.^[30,31]

Phytochemical Constituents

Fresh ginger is composed of around 80.9% water and contains a variety of nutrients, including protein, fat, fiber, and carbohydrates such as starch and pentosans. It is rich in minerals like calcium, phosphorus, and iron,

and also contains small amounts of iodine and fluorine. Additionally, fresh ginger provides several vitamins, including thiamine, riboflavin, niacin, Vitamin C, and carotene, along with small traces of fructose, sucrose, and raffinose.

The major active compounds in ginger include 6-shogaol, 6-gingerol, zingiberol, β -phellandrene, α -zingiberene, ar-curcumen, and β -bisabolene. Other chemical constituents found in ginger are Gingerenones A, B, and C, isogingerenone B, hexahydrocurcumin, gingerdiols, and 6-gingesulfonic acid. It also contains ginger glycolipids A, B, and C, along with compounds like (+) angelicoidenol-2-O- β -D-glucopyranoside, geraniol glycosides, α -santalol, β -eudesmol, nerolidol, farnesol, and various other aromatic compounds such as camphene, myrcene, limonene, 1,8-cineole, and different types of alkanes, alcohols, aldehydes, ketones, and sulfides. These chemicals contribute to ginger's distinct aroma and its wide range of health benefits.^[28]

- **Volatile Oils:** These are the essential oils in ginger, primarily made up of terpenoids, which give ginger its distinctive aromatic scent. The composition of these oils can vary depending on where the ginger is grown.
- **Gingerol:** Gingerol is the compound responsible for ginger's spicy flavor. It is a mixture of several substances, all containing the same functional group, 3-methoxy-4-hydroxyphenyl. Gingerols can be further divided into subtypes like gingerols, shogaols, paradols, zingerones, gingerdiones, and gingerdiols, each with different fatty chains linked to the functional group.
- **Diarylheptanoids:** These are a group of compounds characterized by a 1,7-disubstituted phenyl group and a heptane skeleton. These compounds, which possess antioxidant properties, can be classified into linear and cyclic types.
- **Proteins and Amino Acids:** Ginger contains a range of amino acids, including glutamate, aspartic acid, serine, glycine, threonine, alanine, cystine, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, lysine, histidine, arginine, proline, and tryptophan. It also includes polysaccharides, cellulose, and soluble sugars.
- **Organic Acids:** Ginger is rich in various organic acids, such as oxalic acid, tartaric acid, lactic acid, acetic acid, citric acid, succinic acid, formic acid, and malonic acid.
- **Inorganic Elements:** Over 20 inorganic elements can be found in ginger, including potassium (K), magnesium (Mg), gallium (Ga), manganese (Mn), phosphorus (P), aluminum (Al), zinc (Zn), iron (Fe), and barium (Ba).^[12]

Ginger's medicinal properties are primarily attributed to both its volatile and non-volatile compounds. The volatile compounds are mainly responsible for its characteristic aroma and taste. These include:

- **Monoterpenoids, sesquiterpenoids, and aldehydes**, which contribute to ginger's distinct sensory qualities.
- **Sesquiterpenes** like (-)-zingiberene, (+)-curcumene, (-)- β -sesquiphellandrene, and β -bisabolene are key players in ginger's fragrance.
- **Camphene** offers a camphor-like taste, while **sabinene** provides a hot, peppery, and slightly pungent flavor.
- **α -Curcumene** has a turmeric-like odor and a mildly bitter taste, while **zingiberene** gives off a warm, woody, spicy scent that lingers. **α -Farnesene** produces a subtle, sweet, and warm aroma.
- **Neral and geranial** are typically used to create a strong lemon fragrance.

Non-volatile compounds, particularly **gingerols, shogaols, paradols, and zingerone**, contribute to ginger's pungent taste. **Zingerone**, which forms from gingerols during drying or cooking, is responsible for the warm, spicy sensation in the mouth and is also linked to many of the plant's pharmacological effects. Additionally, ginger's **oleoresins**—which are extracted using solvents—contain compounds such as eugenol, zingerone, trans-6-shogaol, and geranial that further contribute to its potent flavor and medicinal benefits.

These compounds work together to give ginger its unique flavor profile and therapeutic properties.^[11]

EVIDENCE BASED PHARMACOLOGICAL STUDIES

Antimicrobial property

Ginger has demonstrated significant antibacterial properties against both gram-positive and gram-negative bacteria, including various strains such as *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Klebsiella pneumoniae*, *Enterococcus faecalis*, *Salmonella typhi*, *S. typhimurium*, *Pseudomonas aeruginosa*, *Proteus* species, *Bacillus cereus*, *B. subtilis*, *B. megaterium*, and *Streptococcus faecalis*.

Studies have shown that compounds like gingerenone-A and shogaol in ginger inhibit a unique enzyme in *Staphylococcus aureus*, providing antibacterial benefits. Research by Noori and colleagues found that a nano-emulsion coating with ginger had comparable antimicrobial effectiveness to gentamicin, a standard antibiotic. Another study by Mostafa in 2018 confirmed that a nanoemulsion of ginger's volatile oil was stable and effectively combated *Streptococcus mutans*.

In other research, ethanol extracts of ginger showed substantial antibacterial action against *P. aeruginosa* and *B. subtilis*, with inhibition zones ranging from 7 mm to 23 mm at concentrations of 6.25 to 100 mg/ml, and minimum inhibitory concentrations (MIC) from 6.25 to 12.5 mg/ml. Although aqueous ginger

extracts were less effective at lower doses, higher concentrations exhibited stronger antibacterial effects.

Further studies using fresh, natural, and commercially dried ginger extracts tested against clinical bacterial isolates showed that chloroform and diethyl ether extracts created larger inhibition zones for many pathogens, with the exception of *P. aeruginosa* and *E. coli*. Additionally, methanolic extracts of ginger tested through the agar diffusion method showed promising antibacterial activity when compared with standard antibiotics.^[11]

Serum and Hepatic Cholesterol Lowering Activity

Studies have shown that ginger oleoresin, when taken orally, can significantly reduce cholesterol levels in both the blood (serum) and liver. Additionally, it promotes the excretion of cholesterol through feces, indicating its potential as a natural remedy for managing cholesterol levels.

Nutraceutical Agent against Liver Fibrosis

Successive extracts from ginger rhizomes (using petroleum ether, chloroform, and ethanol) have been studied for their effects on liver fibrosis in rats caused by carbon tetrachloride (CCl₄). The treatment with these extracts significantly boosted levels of important antioxidants and liver enzymes, including glutathione, superoxide dismutase (SOD), sorbitol dehydrogenase (SDH), lactate dehydrogenase (LDH), glucose-6-phosphatase (G6-Pase), alkaline phosphatase (AP), and 5'-nucleotidase (5'NT). At the same time, levels of harmful markers associated with liver damage—such as plasma malondialdehyde (MDA), aspartate transaminase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and total bilirubin—were notably reduced. Among the extracts, the ethanol extract showed particular promise, making it a strong candidate for treating CCl₄-induced liver fibrosis.

Anti-Inflammatory and Analgesic Activity

Research on the rhizome extract of *Zingiber officinale* has revealed its anti-inflammatory and pain-relieving effects in albino rats and Swiss mice. Administered at doses of 50 and 100 mg/kg body weight, the extract significantly reduced inflammation in rats, as measured by the inhibition of carrageenan-induced paw swelling, and decreased pain responses in mice, indicated by fewer writhing movements caused by acetic acid. These findings suggest that *Z. officinale* rhizome extract contains compounds with strong anti-inflammatory and analgesic properties.

Spermatogenic Activity

Ginger has shown beneficial effects on sperm production and quality due to its antioxidant properties. In a study, two groups of rats were given ginger rhizome powder at doses of 50 and 100 mg/kg daily for 20 days. At the end of the trial, testes tissues were collected, and sperm from

the epididymis was analyzed. Results demonstrated that the 100 mg/kg/day dose of ginger significantly improved sperm count, viability, motility, and increased serum testosterone levels, indicating ginger's potential in supporting reproductive health.

Antimicrobial and Cytotoxic Activity

A study examined the cytotoxic effects of ethanol and chloroform extracts from the edible plant *Zingiber officinale* (ginger) on human cervical cancer (HeLa) and mouse fibroblast (L929) cell lines. The extracts were prepared and tested against these cell lines to evaluate their potential anti-cancer properties.

Anxiolytic and Antiemetic Activity

The benzene fraction (BF) from a petroleum ether extract of dried ginger rhizomes has shown promising anxiolytic and antiemetic effects. Testing revealed that while BF did not impair motor coordination on its own, it did enhance diazepam-induced motor incoordination. In behavioral tests, animals treated with BF spent more time in open arms of an elevated plus maze, indicating reduced anxiety. Additionally, BF blocked lithium sulfate-induced place aversion, suggesting antiemetic properties. These results indicate that the benzene fraction of ginger rhizome extract may contain compounds with anxiolytic, antiemetic, and potentially anticonvulsant effects.

Cytoprotective and Anti-Ulcer Activity

The 96% ethanolic extract of *Zingiber officinale* (ginger) has demonstrated strong cytoprotective effects in albino rats, safeguarding cells from damage caused by harsh agents like 80% ethanol, 0.6M HCl, 0.2M NaOH, and 25% NaCl. Administered at a dose of 500 mg/kg body weight following a 36-hour fasting period, this extract significantly reduced cell destruction. Additionally, ginger extract was found to protect against gastric ulcers caused by NSAIDs and stress induced by hypothermic restraint, highlighting its potential as a protective agent for the stomach lining under various stress conditions.

Antimicrobial activity

A study on the antimicrobial properties of an ethanolic extract of *Zingiber officinale* at a concentration of 20 mg/ml showed activity against *Pseudomonas aeruginosa* and *Escherichia coli*. However, the extract had minimal inhibitory effect on *E. coli*, possibly due to insufficient release of active compounds from the raw extract, suggesting that further refinement might enhance its effectiveness.

Antifungal activity

Research on the antifungal and anti-biofilm effects of ginger extract has shown promising results against *Candida* species. The extract demonstrated strong antifungal activity and effectively inhibited biofilm formation by *Candida albicans* and *Candida krusei*, suggesting its potential use as a natural remedy for fungal infections associated with these pathogens.^[32]

Radioprotective Effect

Studies indicate that hydroalcoholic extracts of *Zingiber officinale* (ginger) rhizome show protective effects against gamma radiation-induced sickness and mortality in mice, primarily due to the actions of compounds like dehydrogingerone and zingerone. Notably, zingerone appears to protect healthy tissues from the harmful effects of radiation in cancer-bearing mice while allowing the tumoricidal effects to proceed. In rats, ginger's hydroalcoholic extract has been found effective in countering radiation-induced gastrointestinal discomfort, including conditioned taste aversion. When administered an hour before exposure to 2-Gy gamma radiation, it significantly reduced aversive responses to saccharin, indicating neurobehavioral benefits potentially linked to ginger's antioxidant properties. These properties include lipid peroxidation inhibition and superoxide anion scavenging, which together provide radio-protective benefits.

In Ayurveda, ginger is valued for its appetite-enhancing and pain-relieving qualities, along with its ability to counter physical weakness, which could be particularly beneficial for managing the fatigue often experienced in radiation therapy.

Anti-cancer Effect

The active compounds in *Zingiber officinale* (ginger) - including 6-gingerol, 6-shogaol, 6-paradol, and zerumbone - demonstrate significant anti-inflammatory and anti-tumorigenic effects, offering potential for the prevention and management of cancers such as colorectal, gastric, ovarian, liver, breast, and prostate. Ginger's effects are attributed to its ability to activate protective enzymes like glutathione peroxidase, glutathione S-transferase, and glutathione reductase, which play roles in reducing colon cancer risk. Zerumbone, in particular, when administered orally, has been shown to reduce the formation of colonic adenocarcinomas by decreasing colonic inflammation, suppressing cell proliferation, inducing apoptosis, and downregulating NF- κ B and heme oxygenase-1 (HO-1) expression.

In cases of gastric carcinoma, ginger's bioactive molecules like gingerol and shogaol help suppress inflammation and promote cancer cell death by inhibiting NF- κ B and activating caspase-3/7, which triggers apoptosis. Gingerol has also been effective in liver cancer by arresting the cell cycle and inducing apoptosis. Additionally, gingerol can inhibit the growth of human epidermoid carcinoma cells through the generation of reactive oxygen species (ROS), though it can present some toxicity.

Furthermore, *Z. officinale* supports ovarian cancer control by inhibiting NF- κ B activation and reducing levels of vascular endothelial growth factor (VEGF) and IL-8. Zerumbone also shows potential in managing pancreatic cancer by enhancing p53 pathway signaling,

increasing caspase-3 activity, and promoting apoptosis. Ginger's broad benefits also include improving circulation, supporting nervous and heart functions, aiding digestion, and stimulating appetite, which together contribute to immunity enhancement and reduce the risk of abnormal cell growth.^[33]

RESULTS AND DISCUSSION

Ginger is a plant renowned for its diverse bioactive compounds, including gingerols, shogaols, and paradols, which are responsible for its impressive health-promoting properties. Extensive research has demonstrated ginger's potent antioxidant, anti-inflammatory, and antimicrobial effects, etc., validating its traditional use in various ailments. While in vitro and animal studies have yielded promising results, further rigorous clinical trials are necessary to confirm these benefits in humans. To fully harness ginger's therapeutic potential, future research should focus on identifying and characterizing additional bioactive compounds and elucidating their mechanisms of action. By doing so, scientists can solidify ginger's position as a natural therapeutic agent and unlock its potential applications in modern medicine, potentially leading to innovative treatments and health solutions.

Source of Funding

None.

Conflict of Interest

All authors declare no conflict of interest.

ACKNOWLEDGEMENT

I am thankful to my coauthors for their support. I acknowledged those whose papers, articles, and books are cited in this paper.

REFERENCES

1. Ma RH, Ni ZJ, Zhu YY, Thakur K, Zhang F, Zhang YY, et al. A recent update on the multifaceted health benefits associated with ginger and its bioactive components. *Food & Function*, 2021; 12(2): 519-42.
2. Menon V, Elgharib M, El-awady R, Saleh E. Ginger: From serving table to salient therapy. *Food Bioscience*, 2021; 100934.
3. Nadkarni KM. *Indian plants and drugs*. (New Delhi, India: Srishti book distributors) 2005.
4. Kritikar KR, Basu BD. *Indian Medicinal Plants*. 2nd ed. (Dehradun, India: International Book Distributors) 2007; 4.
5. Khare CP. *Indian Medicinal Plants: An Illustrated Dictionary*. (New York, USA: Springer Publications) 2007.
6. Pulliah T. *Encyclopedia of world medicinal plants*. (New Delhi, India: Regency Publication) 2006; 4.
7. Tarannum A. Zanjabeel (Ginger): A Culinary Spice With Its Potential Therapeutic Applications. *International Research Journal of Pharmaceutical and Applied Sciences*, 2015; 5(1): 1-6.
8. Akbar S. *Handbook of 200 Medicinal Plants* [Internet]. Cham: Springer International Publishing; 2020. Available from: <http://link.springer.com/10.1007/978-3-030-16807-0>
9. Khan A, Muhit Azam. New Delhi (India): Central Council for Research in Unani Medicine, Department of AYUSH, Ministry of Health and Family Welfare, Government of India, 2013; 02.
10. Ghani M, Khazainul Advia. (Urdu). New Delhi (India): Idara Kitab al Shifa, 2011.
11. Aleem M, Khan MI, Shakshaz FA, Akbari N, Anwar D. Botany, phytochemistry and antimicrobial activity of ginger (*Zingiber officinale*): A review. *Int J Herb Med.*, 2020 Nov 1; 8(6): 36-49.
12. Ansari FR, Chodhary KA, Ahad M. A review on ginger (*Zingiber officinale* Rosc) with unani perspective and modern pharmacology. *Journal of Medicinal Plants*, 2021; 9(3): 101-4.
13. Department of Indian Systems of Medicine & Homoeopathy. *The Unani pharmacopoeia of India*. Vol. 4 Part 1. (New Delhi, India: GOI Ministry of Health and Family welfare, Dept. of AYUSH) 2007.
14. Ebadi M. *Pharmacodynamic basis of herbal medicine*. 2nd ed. (Boca Raton, USA: CRC Press) 2007.
15. *The Unani Pharmacopoeia of India*. Part 1. New Delhi: GOI Ministry of Health and Family Welfare, Dept. of AYUSH, 2007; 1: 88-89.
16. Kabeeruddin M, Makhzanal Mufradat. New Delhi: Ejaz Publishing House; YNM: 366-367.
17. Ghani N. *Khazain al-advia*. New Delhi: Idara Kitab us Shifa; YNM 869-870.
18. Rafiquddin M. *Kanzul Advia Mufarrada*. Aligarh: Muslim University Press, 1985; 76-78.
19. Kabeeruddin M. *Ilmul Advia Nafisi*. New Delhi: Ejaz Publishing House, 2007; 114.
20. Ibnul Qaf. *Kitabul Umda fil Jarahat* (Urdu translation). New Delhi: CCRUM; YNM, 289, 2.
21. Baitar I. *Al-jame' limufradat al-advia wa al-aghziya*, Vol. 2. New Delhi: CCRUM, 2000; 349-352.
22. Razi AMZ. *Kitabul Mansoori*. New Delhi: CCRUM, 1991; 144: 136-138.
23. Ibn Seena SBA. *Kitab al-qanoon fi al-tib* (Urdu translation by Ghulam Hasnain Kantoori). New Delhi: Idarae Kitab us Shifa; YNM 328.
24. Mohammad AH, Bustanul Mufradat. (Reprint) *Idarae Kitab-us Shifa*, New Delhi YNM 60.
25. Duke JA. *Handbook Of Medicinal Herbs*. CRC Press; 2002.
26. Anonymous. *The Ayurvedic Pharmacopeia Of India Part-I, Vol-I*. First Ed. New Delhi: Govt. Of India, Ministry Of Health And Family Welfare, Department Of AYUSH; 2001.
27. Anonymous. *The Unani Pharmacopoeia of India Part-I Vol-I*. New Delhi: Govt. Of India, Ministry Of Health And Family Welfare, Department Of AYUSH; 2007.

28. Naaz A, Viqar U, Ammara AU, Jabeen J, Minhajuddin A. Zanjabeel (*Zingiber officinale* Roscoe.)—A concise review on culinary spice with its potential therapeutic applications.
29. Sina I. *Al-Qānūn Fi'l-Ṭibb* (English Translation) Part II. New Delhi: Jamia Hamdard, New Delhi; 1998.
30. Liu Y, Liu J, Zhang Y. Research Progress on Chemical Constituents of *Zingiber officinale* Roscoe. *BioMed research international* 2019.
31. Mascolo N, Jain R, Jain SC, Capasso F. Ethnopharmacologic investigation of ginger (*Zingiber officinale*). *Journal of ethnopharmacology*, 1989; 27(1- 2): 129-40.
32. Naaz A, Viqar U, Ammara AU, Jabeen J, Minhajuddin A. Zanjabeel (*Zingiber officinale* Roscoe.)—A concise review on culinary spice with its potential therapeutic applications.
33. Dissanayake KG, Waliwita WA, Liyanage RP. A review on medicinal uses of *Zingiber officinale* (ginger). *International Journal of Health Sciences and Research*, 2020 Jun; 10(6): 142-8.