**Functional Properties of Ginger in Ancient and Contemporary Science**

**ABSTRACT**

Ginger (*Zingiber officinale* Roscoe) was a revered rhizomatous herb known for its culinary and medicinal applications across various cultures. This review integrated traditional knowledge and modern scientific findings on ginger's therapeutic properties, particularly its ability to alleviate ailments such as nausea, digestive disorders, and respiratory issues. A detailed literature search was carried out using various databases, such as PubMed and Scopus. The focus was on peer-reviewed articles, ethnopharmacological surveys, and ancient texts, all published until 2024. Each source was carefully reviewed to ensure a thorough and informative exploration. Key bioactive compounds, including [6]-gingerol, [6]-shogaol, and zingerone, were identified for their potent anti-inflammatory, antioxidant, and anticancer effects. These compounds mitigated oxidative stress and inflammation, supporting ginger's role in managing conditions like arthritis and metabolic disorders. Recent studies clarified the biochemical mechanisms through which ginger produced these effects, including its ability to inhibit inflammatory pathways, enhance gastrointestinal function, alleviate nausea through receptor antagonism, and promote respiratory health. The review emphasized the rich historical importance of ginger in traditional healing practices, illustrating its revered status across cultures. Additionally, it substantiated its medicinal benefits through modern scientific research, bridging ancient wisdom with contemporary health insights for a comprehensive understanding of ginger's efficacy. The findings advocated for further clinical trials to explore ginger's therapeutic potential and its interactions with other treatments, reinforcing its value in integrative health practices. This synthesis underscored ginger's multifaceted benefits and its importance in promoting health and wellness.

**KEYWORD:** Anticancer, antioxidant, ginger, gingerol, health, medicinal

**1. INTRODUCTION**

Ginger (*Zingiber officinale* Roscoe) is a distinguished rhizomatous herb from the Zingiberaceae family, celebrated not only for its culinary applications but also as one of the most ancient and widely embraced medicinal plants across cultures (Nair, 2019). This perennial herb, native to Southeast Asia, has been cultivated for thousands of years and has spread globally due to its versatile uses and adaptability to various climates. The plant is characterized by its thick, knotted rhizomes, which are the primary source of its medicinal and culinary value (Sunanda et al., 2017). In traditional medicinal frameworks such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani, ginger has been revered for its remarkable ability to restore equilibrium among the body's humors, essential for maintaining health (Baliga et al., 2011). These ancient healing systems have long recognized ginger's potential to harmonize bodily functions and promote overall well-being. It has been employed to alleviate a wide spectrum of ailments, ranging from the discomforts associated with the common cold, including cough and congestion, to various gastrointestinal disturbances such as nausea, indigestion, and bloating (Indiarto et al., 2021).

The versatility of ginger in traditional medicine is matched by its rich phytochemical profile. The rhizome contains a complex mixture of bioactive compounds, including volatile oils, phenolic compounds, and oleoresins. These components contribute to ginger's characteristic pungent flavor and aroma, as well as its therapeutic properties (Dev and Sharma, 2022). The most notable bioactive compounds in ginger are gingerols, shogaols, and paradols, which are responsible for many of its pharmacological effects (Prasad and Shivay, 2020). In recent years, the scientific community has directed significant attention towards ginger due to its diverse and potent pharmacological properties. Research has revealed that key bioactive compounds in ginger, most notably [6]-gingerol, [6]-shogaol, and zingerone, exhibit powerful anti-inflammatory, antioxidant, and anticancer effects (Wakchaure and Ganguly, 2018; Mao et al., 2019). These constituents have been shown to play critical roles in mitigating oxidative stress, reducing markers of inflammation, and interfering with pathways involved in carcinogenesis (Aregawi et al., 2022). The anti-inflammatory properties of ginger have been extensively studied, with research indicating its potential in managing chronic inflammatory conditions such as osteoarthritis and rheumatoid arthritis (Baek et al., 2024). Ginger's ability to inhibit the production of pro-inflammatory cytokines and modulate inflammatory pathways has garnered interest in its application for various inflammatory disorders (Zhou et al., 2022). Ginger's antioxidant capacity is another area of significant research focus. The herb's ability to scavenge free radicals and enhance the body's natural antioxidant defenses has implications for preventing oxidative stress-related diseases, including cardiovascular disorders and neurodegenerative conditions (Zarezadeh et al., 2019). Studies have shown that regular consumption of ginger can increase antioxidant enzyme activities and reduce lipid peroxidation, contributing to its protective effects against oxidative damage (Kiyama, 2020). The anticancer potential of ginger has also been a subject of intense investigation. Preclinical studies have demonstrated that ginger extracts and their bioactive compounds can inhibit the proliferation of various cancer cell lines, induce apoptosis, and suppress tumor growth (Baliga et al., 2011). While more clinical research is needed, these findings suggest promising avenues for ginger in cancer prevention and as an adjunct to conventional cancer therapies.

This review was grounded in a comprehensive analysis of existing literature. A thorough search was conducted across several prestigious databases, including PubMed, Scopus, Google Scholar, and Web of Science. The search utilized a carefully curated selection of key terms, such as "ginger pharmacology," "Zingiber officinale," "ginger traditional medicine," "gingerol anti-inflammatory," and "ginger antioxidant."

The purpose of this review was to integrate the extensive body of traditional knowledge regarding ginger's therapeutic applications with the latest discoveries in modern scientific inquiry. By providing a comprehensive analysis of ginger's functional properties, this review aimed to underscore its historical significance while advancing our understanding of its roles in contemporary health and wellness paradigms. The synthesis of ancient wisdom and cutting-edge research offers a unique perspective on ginger's potential to address a wide range of health concerns, from common ailments to chronic diseases.

**2. GINGER IN ANCIENT MEDICAL SYSTEMS**

*2.1 Ayurveda:*

Within the ancient Indian medical system of Ayurveda, ginger was highly esteemed for its diverse therapeutic properties and was referred by two distinct names: *Shunthi* (when desiccated) and *Ardraka* (when in its fresh form) (Nair, 2019). This rhizome was particularly noted for its capacity to enhance the body’s digestive fire, a concept termed *Agni Deepana*, which was integral to optimal digestion and metabolic function (Mansour et al., 2012). Additionally, ginger facilitated detoxification (*Ama Pachana*) through the elimination of toxic substances, while concurrently assisting in the balancing of the *Vata* and *Kapha doshas*, thus fostering comprehensive health (Pal, 2014). As a multifaceted remedy, ginger was indicated in the management of a range of ailments, including arthritis, where it was recognized for its analgesic properties, as well as in the alleviation of nausea associated with pregnancy or motion sickness, addressing respiratory challenges such as cough, and mitigating digestive disorders, including indigestion and bloating (Ostadmohammadi et al., 2019; Hardi et al., 2024).

2.*2 Traditional Chinese Medicine (TCM):*

Within the framework of Traditional Chinese Medicine, ginger was categorized as Sheng Jiang (fresh ginger) and Gan Jiang (dried ginger), and was prized for its warming attributes that were believed to counteract internal cold, which might induce imbalances within the body. Ginger was frequently employed to relieve nausea, particularly in individuals enduring digestive irregularities, and was pivotal in promoting digestive equilibrium. By enhancing the circulation of qi (vital energy) and optimizing digestive function, ginger significantly contributed to overall wellness and bodily balance (Zhang et al., 2024).

*2.3 Unani Medicine:*

In the esteemed tradition of Unani medicine, ginger was acknowledged for its carminative, aphrodisiac, and stimulant characteristics. It was often incorporated into complex polyherbal formulations, thereby amplifying its health benefits. The utilization of ginger within these remedies underscored its importance in traditional practices aimed at enhancing vitality, improving digestive health, and stimulating appetite (Ahmad et al. 2012).

**3. BIOACTIVE COMPOUNDS IN GINGER**

*3.1 Gingerols:*

Among the primary bioactive constituents located in fresh ginger were gingerols, which were primarily responsible for its distinctive sharp flavor and aroma. These compounds were celebrated for their significant antioxidant and anti-inflammatory properties, which mitigated oxidative stress and inflammation throughout the body, thereby promoting overall health (Promdam and Panichayupakaranant, 2022).

*3.2 Shogaols:*

Upon the drying or heating of ginger, gingerols undergone conversion into shogaols, compounds that exhibited markedly heightened anti-inflammatory activity. Shogaols played a critical role in diminishing the levels of inflammatory mediators in the body, thus providing effective relief for a spectrum of inflammatory conditions, including arthritic pain and inflammatory bowel disorders (Maghraby et al., 2023).

*3.3 Zingerone and Paradols:*

In addition to gingerols and shogaols, ginger incorporated other valuable compounds such as zingerone and paradols. These constituents contributed to the pharmacological profile of ginger through their antiemetic (anti-nausea), antimicrobial, and potential chemopreventive effects, establishing ginger as a multifaceted agent in both traditional and contemporary medical practices (Zhukovets and Ozcan, 2020).

**4. FUNCTIONAL PROPERTIES**

*4.1 Anti-inflammatory:*

The anti-inflammatory properties attributed to ginger were substantial, arising from its capacity to inhibit specific pathways implicated in inflammation, notably the cyclooxygenase and lipoxygenase pathways (Schor, 2014). This inhibition resulted in a significant reduction of pro-inflammatory cytokines, including TNF-α and IL-6. Notably, shogaols were recognized for their ability to inhibit the NF-κB signaling pathway, further augmenting the anti-inflammatory effects of ginger, thus providing relief for conditions such as arthritis and chronic inflammatory diseases (Aregawi et al., 2022).

*4.2 Antioxidant:*

Ginger was acclaimed for its potent antioxidant capabilities, with both gingerols and shogaols effectively scavenging detrimental reactive oxygen species (ROS) within the body. This antioxidant activity not only safeguarded cellular and tissue integrity but also stimulated the body's endogenous antioxidant defenses, promoting the synthesis of critical biomolecules such as glutathione and superoxide dismutase (SOD), thereby enhancing cellular health and longevity (Danwilai et al., 2017).

*4.3 Antiemetic:*

The antiemetic properties of ginger were substantiated by substantial research, particularly its role as an antagonist to serotonin receptors located in the gastrointestinal tract and central nervous system. This mechanism proved particularly advantageous for individuals experiencing nausea and vomiting related to chemotherapy, pregnancy, or motion sickness, providing a natural and effective means of alleviating these distressing symptoms (Levine et al., 2008; Crichton et al., 2024).

*4.4 Antimicrobial:*

Ginger exhibited antimicrobial properties across a broad spectrum of pathogens. Research had demonstrated its efficacy against various bacterial strains, including Staphylococcus aureus, Escherichia coli, and Helicobacter pylori (Siddaraju and Dharmesh, 2007). These antimicrobial capacities underscored ginger's potential as a natural adjunct in enhancing immune function and preventing infectious diseases.

*4.5 Anticancer:*

Emerging research indicated that compounds found in ginger possess anticancer properties. They might work by suppressing the proliferation of tumor cells, inducing programmed cell death (apoptosis), and inhibiting the formation of new blood vessels (angiogenesis) that tumors require for growth. Multiple studies have shown promise regarding ginger's efficacy against various cancer types, including colorectal, breast, and ovarian cancers, suggesting a valuable role for ginger in complementary cancer therapies (Citronberg et al., 2013).

*4.6 Metabolic Effects:*

Ginger also shows promise in assisting with metabolic regulation, particularly by lowering blood sugar and lipid levels (Talaei et al., 2018). This characteristic was especially significant for individuals suffering from metabolic syndrome and obesity, indicating that incorporating ginger into a balanced diet might enhance metabolic health and wellness.

**5. COMPARATIVE ANALYSIS BETWEEN ANCIENT MEDICINAL PRACTICES AND MODERN SCIENCE**

Table1 illustrated the remarkable continuity between ancient medicinal practices and modern scientific validation of ginger's therapeutic properties. Ancient civilizations utilized ginger for its anti-inflammatory, digestive, antiemetic, and respiratory benefits, which have now been corroborated by contemporary research. Modern studies have elucidated the mechanisms underlying these traditional uses, revealing ginger's ability to inhibit inflammatory pathways, enhanced gastrointestinal function, antagonize specific receptors to alleviate nausea, and improve respiratory health. This alignment between historical applications and current scientific understanding underscored the enduring value of traditional herbal knowledge and its potential to inform modern pharmacological research and therapeutic strategies.

Table 1: Ancient use and modern validation of therapeutic properties of ginger

|  |  |  |  |
| --- | --- | --- | --- |
| Property  | Ancient use  | Modern validation | Reference |
| Anti-inflammatory  | Used to alleviate symptoms of arthritis, pain, and joint swelling  | Proven to inhibit prostaglandins and NF-κB pathways, confirming its anti-inflammatory efficacy  | (Mozaffari-Khosravi et al., 2016) |
| Digestive aid  | Historically used to address indigestion, bloating, and colicky pain  | Stimulates bile secretion and enhances gastrointestinal motility, aiding digestion and nutrient absorption  | (Prakash and Srinivasan, 2013) |
| Antiemetic  | Traditionally employed to relieve morning sickness and general nausea  | Functions as a 5-HT3 receptor antagonist, effectively mitigating nausea and vomiting in various contexts  | (Kim et al., 2023) |
| Respiratory relief  | Used to alleviate symptoms of coughs, asthma, and nasal congestion  | Demonstrated to provide bronchodilation and exhibit anti-allergic effects, thus improving respiratory function  | (Kim et al., 2021) |
| Antioxidant  | Associated with improved longevity and overall vitality  | Verified to scavenge reactive oxygen species and enhance antioxidant production in the body  | (Danwilai et al., 2017) |

**6. CONCLUSION**

Ginger had long been recognized in traditional medicine for its holistic health benefits. Modern research had started to uncover the biochemical mechanisms behind its therapeutic properties, primarily through compounds like gingerol and shogaol. Future studies were expected to prioritize well-designed clinical trials to evaluate ginger's efficacy and safety, standardize extracts for consistent potency, and investigate its interactions with other medicinal agents. Ultimately, these efforts aimed to enhance the understanding of its role in health promotion and disease prevention.

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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