Journal of Ayurvedic and Herbal Medicine 2024; 10(2): 49-55

Review Article

ISSN: 2454-5023
J. Ayu. Herb. Med.
2024; 10(2): 49-55
Received: 14-03-2024
Accepted: 23-05-2024

www.ayurvedjournal.com
DOI: 10.31254/jahm.2024.10205

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Health Benefits of Ginger: A Review

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ABSTRACT

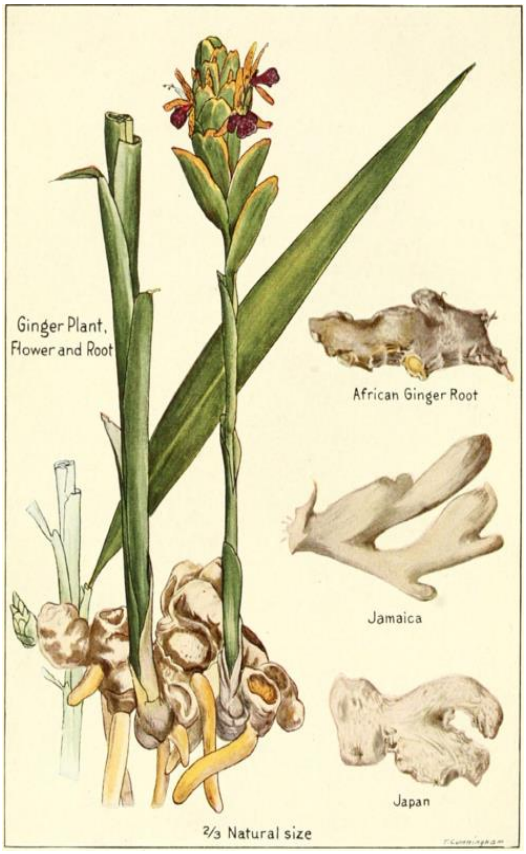
Indian kitchens use ginger (*Zinger officinale*), a natural healing food. Ginger offers a variety of health-promoting properties and diverse phytochemistry. *Zingiber officinale* is one of the most commonly used species in the ginger family, and it can be found in various meals and drinks. Ginger is frequently used to alleviate nausea, indigestion, diarrhoea, and upset stomachs. It also possesses antioxidant and anti-inflammatory qualities. It is determined that because of its antioxidants and anti-inflammatory qualities, it may be used to cure various illnesses, including cancer. It is also helpful in managing the aging process. Due to its biological properties, which include anti-inflammatory, antiviral, antibacterial, antifungal, antihyperlipidemic, anti-obesity, and hepatoprotective properties, ginger has been shown to benefit human health. Products made from the rhizomes of ginger were employed in herbal medicine, meals, and drinks. Because of its many applications and useful values, it is crucial to ensure its legitimacy. Since authenticity is linked to the product's quality, safety, and efficacy, it is crucial for quality control. The phytochemical compositions, biological activity, and authentication examination of ginger rhizomes were the main topics of this paper. Ginger is a good source of medicinal and nutraceutical goods because of its biological activity.

Keywords: Ginger, Antioxidant, Phytochemistry, Hepatoprotective activity, Herbal medicine.

INTRODUCTION

For millennia, people have utilized ginger (*Zingiber officinale Roscoe*), a well-known herbaceous plant, as a flavoring and herbal remedy. The meat of ginger rhizomes varies in color from white to red, depending on the cultivar. The brown skin of the plant can be either thin or thick, depending on when it was harvested as a young or mature plant. Fresh ginger is used as a flavoring in beverages and the preparation of meat and vegetable products in China and India [1]. In addition, ginger rhizome is a common traditional medicine for relieving pain, nausea, and vomiting, among other common health issues [2]. A study conducted by Ali, [3] claims that over 100 chemicals have been identified in ginger. As per Mahomoodally [4], the primary categories of chemicals found in ginger are gingerol, shogaols, zingiberene, and zingerone. Terpenes, vitamins, and minerals are among the less often occurring compounds in ginger plants. According to Kubra, [5], gingerols are among them and are thought to be the main constituents. They have been shown to have several functions. Antioxidant, antibacterial, and anti-neuroinflammation properties are only a few of the many linked biological activities that have been investigated as a result [6]. Furthermore, the benefits of ginger have been linked to cancers, weariness, and improvements in the quality of life for those who work daily [7, 8]. All of these benefits have been observed in recent years. A campaign known as "Saving Plants for Saving Lives" has been supported by the World Health Organisation (WHO). This is due to the increased knowledge of the critical function that medicinal plants play in offering herbal treatments for many illnesses. With over 8,000 different species, India boasts a wealth of medicinal plant resources. For over 65% of the population, traditional medicines remain their only source of healthcare, according to the Government of India (GOI). An ability to satiate hunger and cure wounds must have come to man first—the knowledge of helpful plants [9]. Due to the presence of some bioactive chemicals called gingerols, zingerone, shogaols, gingerenone A, paradols, 6-dehydrogingerdione, and quercetin, ginger has been found as a natural medicinal agent that can help lessen the negative effects of pharmaceutical treatment. Additionally, ginger includes terpene chemicals such as zingiberene, β-curcumene, β-bisabolene, and β-sesquiphellandrene. Because it contains lipids, fibers, polysaccharides, and organic acids, ginger has potent anti-inflammatory and antioxidant qualities [10]. Numerous pharmacological studies have been carried out recently due to the outstanding health-promoting effects of ginger. As a result, we discussed the health benefits of ginger in this review along with the bioactivities of its constituents and possible paths of its active ingredients.

2: Botanical Classification:
Kingdom- Plantae
Subkingdom- Tracheobionta
Superdivision- Supermatophyta
Division- Magnoliophyta
Class- Liliopsida- Monocotyledons
Subclass- Zingiberidae
Order- Zingiberales
Family- Zingiberaceae
Genus- Zingiber P. Mill
Species- Zingiberofficinale Roscoe



3: Bioactive Compound: Ginger has been shown to have over 400 different chemicals through chemical research. Lipids (3-5%), carbohydrates (50–70%), phenolic compounds, and terpenes are the main ingredients of ginger [11]. The components of ginger oil include a variety of monoterpenes like phellandrene, camphene, cineole, linalool, limonene, citral, geraniol, citronellol, and borneol; sesquiterpenes like α-zingiberene, ar-curcumene, β-bisabolene, β-sesquiphellandrene, zingiberol, and zingiberenol, as well as some aliphatic aldehydes and alcohols [12]. The distinctive bioactive components of ginger are these non-volatile phytochemicals, which have strong tastes and smells. These three non-volatile active chemicals—gingerol, shogaol, and zingerone—combine to give ginger its unique aroma and flavor. One to three percent of fresh ginger's weight is composed of these compounds. Based on research conducted by Singh [13] and [14] Jolad, there are two common components found in all pungent compounds of ginger: vanillyl (4-hydroxy-3-methoxphenyl) and the ketone functional group. Ginger extract and essential oil are not the same bioactive mixture; the essential oil is mostly made up of ginger's volatile oils. Sesquiterpene hydrocarbons and monoterpenes are the two primary classes into which the functional components of ginger essential oil fall. According to Mahboubi, [15], the freshness and origin of the ginger rhizome have an impact on the chemical makeup of the essential oil. The yellow-colored, strong oil known as gingerol is also available as a crystalline solid with a low melting point. The length of the unbranched alkaline chain determines which gingerols are categorized as 4-, 6-, 8-, 10-, and 12-gingerol. Although significant levels of 8- and 10-gingerol can also be found in fresh ginger, 6-gingerol is the most widely distributed form of gingerol [16, 17]. 6-Gingerol is the essential active ingredient of ginger, a somewhat pungent substance with anti-bacterial, anti-inflammatory, and anti-carcinogenic qualities. 6-A variety of health-promoting characteristics of gingerol have been observed, including anti-inflammatory, anti-carcinogenic, antioxidant, cardiotonic and hypotensive, anti-emetic, antipyretic, anti-rheumatic, anti-ulcer, and anti-prostaglandin qualities. Of all the phytochemicals found in ginger, 8-gingerol is the most potent. Several studies have linked it to numerous health advantages [18, 19]. Ginger extract and ginger essential oil have different bioactive compositions. Ginger essential oil is mostly made up of the volatile oils of ginger. The monoterpenes and sesquiterpene hydrocarbons are the two primary classes of bioactive chemicals found in ginger essential oil. The source and state of the ginger rhizome—whether fresh or dried—impact the chemical makeup of ginger essential oil [20]. The bioactive chemicals found in ginger essential oil that are most widely available are α-curcumene, α-zingiberene, geranial, β-sesquiphellandrene, β-bisabolene, and neral. The health-promoting qualities and diverse range of bioactivity of ginger essential oil have also been noted [21].

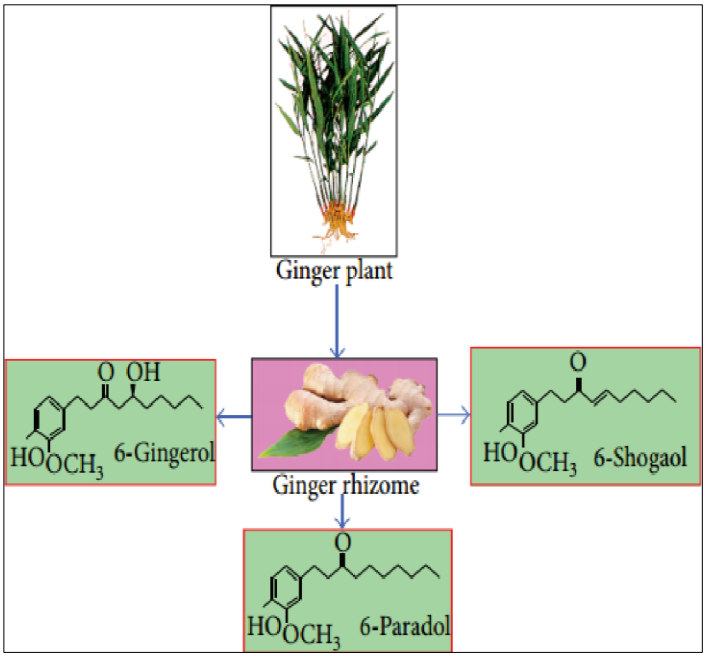


Fig 1: Ginger plant, rhizome, and active components (6-gingerol, 6-paradol, and 6-shogaol) [22].

4: Beneficial activities of Bioactive compounds: As previously noted, the numerous health benefits and favorable properties of ginger's functional and bioactive substances are well-established. This section discusses the many aspects of ginger bioactives' bioactivities as well as their mechanisms of action.

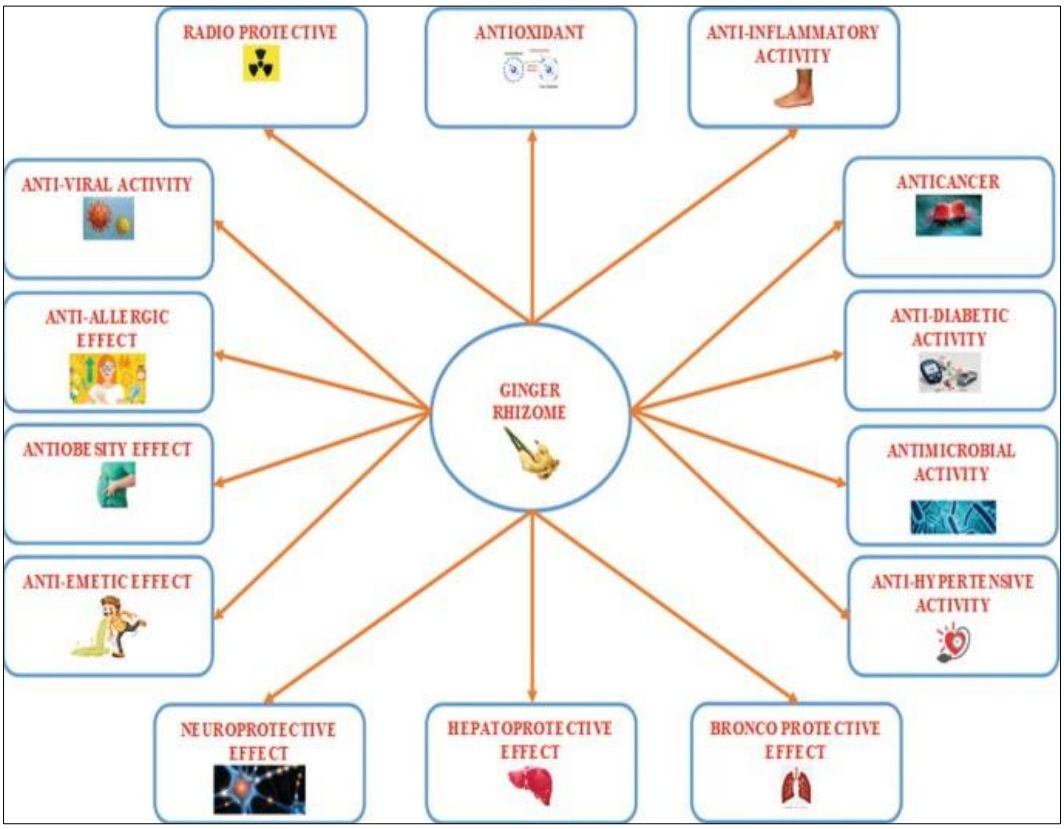


Fig 2: Different activities of Ginger

4.1: Anti-inflammatory activity: Herbs were the primary focus of ancient medical practitioners to strengthen the immune systems of their patients. Ginger and its derivatives strengthen the immune system in several nations [23].

Inhibiting prostaglandin and leukotriene production by inhibiting 5-lipoxygenase or prostaglandin synthetase is how gingerol, shogaol, and other structurally related compounds in ginger work [24, 25]. Moreover, they can prevent the manufacture of pro-inflammatory cytokines such as IL-1, TNF-α, and IL-8. Pan and colleagues conducted an additional study that demonstrated that shogaol can inhibit the production of the inflammatory genes COX-2 and iNOS in macrophages [26, 27]. According to Jung *et al*., Z. officinale's rhizome hexane fraction extract prevented the overproduction of NO, PGE [2], TNF-alpha, and IL-1beta [28].

The strong anti-allergic chemicals found in ginger rhizome suggest that ginger may be helpful in the management and avoidance of allergic illnesses [29]. According to Habib *et al*.'s research, [30], ginger extract can lower the increased production of TNF-α and NFκB in rats with liver cancer. According to Aggarwal [31], there is a connection between the activation of NF-κB and several inflammatory diseases, such as cancer, atherosclerosis, myocardial infarction, diabetes, allergy, asthma, arthritis, Crohn's disease, multiple sclerosis, Alzheimer's disease, osteoporosis, psoriasis, septic shock, and AIDS. The results of studies assessing ginger's efficacy in treating osteoarthritis sufferers are debatable. According to one study, using ginger extract can significantly lessen knee osteoarthritis symptoms [32]. In a different trial, ginger's effects on osteoarthritis were only noticeable during the first several months of therapy [33]. [6]-Shogaol possesses potent anti-inflammatory and antioxidant properties and can be employed as a curative agent in gout, a rheumatic condition of the joints [34].

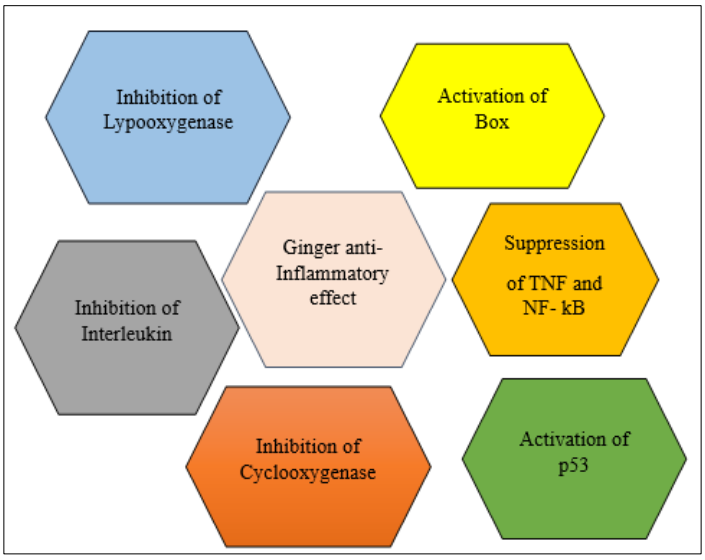


Fig 3: Inflammatory role of ginger in human health

4.2: Antioxidant activities: Antioxidants are substances that help stop free radical damage from occurring by neutralizing them. The prevention and treatment of many diseases are greatly aided by antioxidants. Ginger is regarded as an antioxidant agent because of its significant effects on impeding the development of illnesses and lowering lipid oxidation. In rat liver microsomes, gingerol is implicated in the suppression of lipid peroxidation, and numerous studies have shown that ginger extract functions as an antioxidant and scavenges superoxide anion and hydroxyl radicals [35]. A study that used the freeze-dried, oven-dried, and air-dried procedures examined the antioxidant activity and total phenolic content of ginger. On the other hand, compared to ginger dried by other methods, oven-dried ginger

displayed higher values for each phenolic component identified in this study (36). An investigation into the protective effects of ginger extracts against free radicals in acute renal injury cases was conducted.

The herb known as ginger, *Zingiber officinale*, possesses antioxidant and anti-inflammatory qualities. [37] Rostamkhani found that the results of the meta-analysis support the compelling evidence about the preventive antioxidant activity of ginger extracts in animals suffering from acute renal injury. According to Li, [38], 6-shogaol, 6 Dehydroshogaol, and 1-dehydro-6-gingerdione are nitric oxide inhibitors, while ginger oil and oleoresin exhibit strong antioxidant and antibacterial properties. According to one study by Masuda [39], the presence of the unsaturated ketone moiety in ginger's active component 6-shogaol gives it strong antioxidant features.

4.3: Antidiabetic activities: Ginger and other herbs are useful in diabetes, both as a preventative measure and as a treatment [40]. Several research have demonstrated this. People with type 2 diabetes can effectively control their blood sugar levels using ginger, according to research from the University of Sydney, Australia. Using ginger extracts may help lower blood sugar levels because a study found that they could boost glucose uptake into muscle cells without the need for insulin. In different clinical research, blood glucose, triglyceride, and total and LDL cholesterol levels were dramatically lowered in diabetic individuals who took three grams of dry ginger for thirty days [41, 42]. In diabetic rats, an oral 20-day ethanolic extract of *Zingiber officinale* was found to have a substantial anti-hyperglycemic effect ($p< 0.01$). Additionally, it was discovered that the ethanolic extract of ginger decreased body weight, triglycerides, free fatty acids, insulin, total cholesterol, LDL cholesterol, glucose, and phospholipids in high-fat diets [43]. In general, ginger improves lipid profiles, inhibits enzymes involved in the breakdown of carbohydrates, and increases insulin release and sensitivity in people with diabetes.

Due to its extremely low glycemic index (GI), ginger does not cause blood sugar levels to rise as high-GI foods do. Instead, it gradually breaks down to become glucose. Ginger has been shown in several studies to have a preventative impact against problems related to diabetes. In addition, ginger can lower the chance of cataracts, a major side effect of diabetes, and safeguard a diabetic's liver, kidneys, and central nervous system [41,44,45].

4.4: Anti-cancer activities: Through genetic route modulation, ginger also functioned as an anti-tumor agent. The tumor's suppressive genes are activated with its assistance. Additionally, ginger can modulate apoptosis and decrease vascular endothelial growth factor. [46] Liu has reported that terpenoids, a chemical found in ginger, have been found to activate the tumor protein p53, hence inducing apoptosis in endometrial cancer cells. Whole ginger extract has shown promise in both in vitro and in vivo trials for the treatment of prostate cancer [47]. However, TNF-α in rats' liver cancer blocking was most effective when administered as a ginger extract treatment (100 mg/kg body weight) [30].

In addition, studies by [48] Akimoto have shown that ginger possesses anti-cancer properties against pancreatic cancer [49]. It has conducted experiments on the anti-carcinogenic impact of breast cancer.

4.5: Anti-bacterial activities: Due to its broad range of antibacterial activity against both gram-positive and gram-negative bacteria and fungi, ginger has been used for medicinal purposes for a long time. Ginger can be used to prevent flatulence caused by bacteria that ferment undigested carbohydrates, as evidenced by in vitro tests where active ingredients of the plant hinder the bacterium's ability to multiply [50]. *Proteus species, Salmonella, Staphylococci, Streptococci,* and *Escherichia coli* are all inhibited in their growth by it [51]. According to Nielsen and Rios [52], ginger possesses potent antibacterial and, to a lesser extent, antifungal activities. According to [53] S.P. Nanir and B.B. Kadu, ginger inhibits *Aspergillus sp*., a fungus that produces aflatoxin, a carcinogen. *Aspergillus niger, Sacharomyces cerevisiae*, *Mycoderma sp*., and Lactobacillus acidophilus were all shown to be inhibited by fresh ginger juice. Ginger, a common element in our daily food preparations, can therefore provide defence against bacterial and fungal infections, two of our natural foes.

4.6: Antifungal activities: A molecule with strong antifungal effects found in ginger is called caprylic acid. Apply a cup of boiling water infused with one ounce of ginger root directly to the foot's affected area twice a day, as suggested by Fixer [54] and Hexiang Wang [55]. According to recent studies, plant pathogens including Fusarium oxysporum and Colletotrichum falcatum can be inhibited by the antifungal properties of both ginger extract and ginger essential oil [56, 57]. The phytochemicals in the rhizome are what give it its antifungal qualities. The polyphenolic ketones known as gingerols or oleoresin are the chemical components of ginger extract and essential oil [58]. According to Finger [59], gingerone, dihydrogingerone, and dehydroshogaol are responsible for the antifungal properties of ginger.

4.7: Anticarcinogenic activities: Recent years have seen a significant amount of research on the anti-carcinogenic properties of ginger against a variety of cancer types, including colorectal, prostate, breast, and cervical cancers [60, 61]. Because chronic inflammation is closely associated with all critical phases of the formation of cancer, it plays a major role in carcinogenesis [62]. All phases of cancer formation, including start, promotion, advancement, and medication resistance, are resistant to cancer when ginger and its active components are present. Studies on ginger's cytotoxic effects and mode of action against prostate cancer were conducted both in vitro and in vivo [63]. Through the dysregulation of the protein expression of MRP1 (multi-drug resistance-associated protein 1) and GSTπ (glutathione-S-transferase), it was reported that 6-gingerol, 6-shogaol, 10-gingerol, and 10-shogaol demonstrated significant anti-proliferative effects on prostate cancer cells in humans. By combining ginger bioactives such as 6-gingerol, 8-gingerol, 10-gingerol, and 6-shogaol, it was possible to synergistically inhibit the proliferation of PC-3 prostate cancer cells [64]. 6-Gingerol increases the production of reactive oxygen species (ROS) in human gastric adenocarcinoma (AGS) cells, which lowers the potential of the mitochondrial membrane and encourages death [65]. When 6-shogaol (10–20 μm) was applied in vitro to PC12 cells for 24 hours, it improved the phase II antioxidant compounds in the mouse pheochromocytoma cell line and successfully stopped PC12 cells from proliferating under oxidative stress. As an indication of the significance of the α, β-unsaturated ketone unit in cytoprotection, 6-gingerol, on the other hand, was unable to shield the PC12 cells from oxidative stress. This could be because there was no α, β-unsaturated ketone present [66]

CONCLUSION

In many cultures around the world, ginger is referred to as a spice. There is a wealth of pharmacological value in ginger rhizomes and preparations. As an innovative therapeutic approach against a range of degenerative diseases, ginger, and its bioactive constituents, such as gingerols, shogaol, and paradols, are valuable and active compounds. Ginger has a therapeutic role that makes it a viable substitute for non-steroidal anti-inflammatory medications without seriously harming the kidneys or gastrointestinal tract. Non-steroidal anti-inflammatory medicines, analgesic injections, and chemotherapy are the standard treatments for osteoarthritis, cancer, diabetes, and heart disease. While these treatments are efficient in relieving pain, they can also have unfavorable effects on the gastrointestinal tract and become expensive. A cost-effective, safe, alternative is required to prevent side effects and slow the advancement of diseases to slow down the rate at which they progress. Some genes implicated in various disease-stimulating factors can be suppressed by ginger and its components. This research highlighted the benefits of natural product medications, such as ginger, which have anti-inflammatory and antibacterial properties and are good for gastrointestinal health, diabetes mellitus, and cardiovascular problems. Ginger application is safe and has potential health advantages both now and in the future.

Acknowledgments

The authors express their gratitude to Krishna College of Science and Information Technology, Bijnor, which is affiliated with M.J.P. Rohilkhand University in Bareilly, U.P., India, for providing the facilities necessary to complete this work.

Conflict of interest

There is no conflict of interest.

Funding

None declared.

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HOW TO CITE THIS ARTICLE
Singh J, Nigar I, Kumar D, Sharma S, Kumar H, Rani D, Deepanshi, Rajput U, Mariyam. Health Benefits of Ginger: A Review. J Ayu Herb Med 2024;10(2):49-55. DOI: 10.31254/jahm.2024.10205