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Ginger (Zingiber officinale): A review of varied health benefit

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Ginger (Zingiber officinale): A review of varied health benefit

Abstract

Introduction:

Ginger (Zingiber officinale) is widely valued around the world for its medicinal and culinary properties. Ginger has been used for thousands of years in Traditional Chinese Medicine as a potent curative plant, underscoring its remarkable potential in the realms of nutrition, cuisine and healthcare. A variety of biologically active compounds have been isolated from ginger, including volatile oil, gingerol analogues, diarylheptanoids, phenyl alkaloids, sulfonates, and others. [1] These compounds are known to provide numerous health benefits, such as antioxidant, anti-inflammatory, antimicrobial, or even anti-cancer effects. In addition, accumulating studies have demonstrated that ginger possesses the potential to prevent and manage several diseases, such as neurodegenerative diseases [7], cardiovascular diseases [8],

obesity [9], diabetes mellitus [10], chemotherapy-induced nausea and emesis [11], respiratory disorders [12], and pregnancy-related nausea [2].

Aim of the Study:

The aim of the study is to present the current state of knowledge of ginger, the effects of ginger consumption on health and examples of its use in medical practice.

Materials and methods:

The study was constructed by selecting scientific and medical literature utilizing available databases such as PubMed, Google Scholar, Cochrane Library. Based on searching like: ginger, Zingiber officinale; antioxidant; anti-inflammatory; pregnancy-related nausea; chemotherapy-induced vomiting;

Conclusion

Ginger is an herbal, easily available, low price medication which is associated with low risk and can be substituted for a chemical, scarce and expensive drug. Has a lot of promise in the broad treatment of certain ailments.

Keywords: ginger; Zingiber officinale; antioxidant; anti-inflammatory;

INTRODUCTION

Ginger (Zingiber officinale) is a perennial herbaceous plant, with a long history of cultivation native to East and Southern Asia. It belongs to the Zingiberaceae family, which includes approximately 1,300 species worldwide known for their distinctive aromatic rhizomes. Ginger rhizomes are widely utilized both as a culinary spice and a herbal remedy.

As a spice, ginger plays a significant role in a variety of global cuisines, particularly in Asia, where its sharp, slightly spicy flavor enhances the depth and complexity of dishes. Beyond its culinary use, ginger is also valued for its medicinal properties, commonly employed to treat digestive issues, respiratory ailments, and to alleviate joint pain, highlighting its broad utility in both the kitchen and therapeutic. Recognized by various names across cultures, ginger has been used in Ayurvedic and Traditional Chinese Medicine (TCM) for thousands of years and continues to be incorporated into contemporary medical practices [13,14].

A variety of biologically active compounds have been isolated from ginger, including volatile oil, gingerol analogues, diarylheptanoids, phenyl alkaloids, sulfonates, and others [1]. These compounds are known to provide numerous health benefits. In recent years, research has revealed that ginger exhibits a range of beneficial biological properties of ginger including antioxidant [3], anti-inflammatory [4], antimicrobial [5], and anticancer [6] activities. In addition, accumulating studies have demonstrated that ginger possesses the potential to prevent and manage several diseases, such as neurodegenerative diseases [7], cardiovascular diseases [8], obesity [9], diabetes mellitus [10], chemotherapy-induced nausea and emesis [11], respiratory disorders [12], and pregnancy-related nausea. [2]

Ginger is widely available in grocery shops, supermarkets and markets. It can be purchased in various forms: fresh root, dried powder and also as an ingredient in dietary supplements. Thanks to the global production of ginger, especially in countries such as India, China and Nigeria, its availability is nearly unlimited. Many people can easily incorporate ginger into their diet, making it an accessible health booster. One of the greatest benefits of ginger is its safety in use. Unlike many synthetic drugs, which can cause a number of side effects, ginger is generally well tolerated by most people. Studies show that even with regular use of ginger, the risk of side effects is minimal [21]. The safety issue of ginger essential oil is well documented and is generally regarded as safe [22].

Ginger is an herbal, easily available, low price medication which is associated with low risk and can be substituted for a chemical, scarce and expensive drug. Has a lot of promise in the broad treatment of certain ailments.

AIM OF THE STUDY

Ginger is also highly valued for its numerous health-promoting properties, making it the subject of many scientific studies. The aim of this review is to systematically present and analyze the current state of knowledge regarding the pharmacological properties of ginger and its potential clinical applications.

THE STATE OF KNOWLEDGE: Ginger and its bioactive compounds

Ginger (Zingiber officinale Roscoe) is a source of many valuable bioactive components that exhibit a variety of health-promoting properties. Ginger contains over 400 different compounds, including: carbohydrates (60-70%), water (9-12%), protein (9%), ash (8%), fibre (3-8%) and essential oils (1.5-3%) [25,26,27]. The main groups of these compounds include phenolic compounds, terpenes, lipids, polysaccharides, organic acids, minerals, vitamins and other substances.

1. Phenolic compounds include gingerols (e.g. 6-gingerol, 8-gingerol, 10-gingerol) 23-25% in ginger, shogaols (e.g. 6-shogaol) 18-25% in ginger and paradols (e.g. 6-paradol, 8-paradol). They exhibit strong antioxidant activity, neutralising free radicals and protecting cells from oxidative damage. Gingerols, which predominate in fresh ginger, are converted to shogaols during heat treatment or drying, increasing their pungency and biological activity. Paradols are formed by the hydrogenation of shogaols. These compounds, which act at the cellular level, affect various signalling pathways such as Nrf2, increase the activity of antioxidant enzymes and reduce lipid peroxidation. Ginger also contains other phenolic compounds such as quercetin, zingerone, gingerenone-A and 6-dehydrogingerdione [1,2, 10, 17, 24].
2. Terpenes, which are constituents of ginger essential oils, include β-bisabolene, α-curcumen, zingiberene, α-farnesene and β-sesquifelandrene. These compounds contribute to the antibacterial and antifungal properties of ginger. In addition, these compounds have been shown to interfere with the metabolic processes of bacteria, thereby limiting their ability to reproduce. α-farnesene and β-sesquifelandrene have also been observed to be active against pathogenic fungi, such as Candida albicans. These compounds act by disrupting the integrity of the fungal cell membrane and thereby inhibiting their growth and development. The antifungal action of terpenes may be of particular importance in the context of treating fungal infections and preventing their recurrence. Furthermore, terpenes from ginger have been shown to influence the immune system by modulating the immune response, thereby stimulating the production of pro-inflammatory cytokines and activating immune cells, which in turn supports the body in fighting infections [1,2].
3. Ginger also contains other substances such as polysaccharides, lipids, organic acids, fibre, minerals: calcium, iron, magnesium, manganese, phosphorus, potassium, sodium, zinc and vitamins: vitamin C, E, K, thiamin, riboflavin, niacin, vitamin B6, folic acid, pantothenic acid [1].

The chemical composition of ginger is rich and varied, and has a diverse range of effects on the human body. These include anti-inflammatory effects, which are associated with modulation of nuclear factor kappa B (NF-κB) and the interleukin-1 beta signalling pathway. [1,2,3,4,5] Ginger and its active constituents, such as 6-gingerol and 6-shogaol, have also been shown to have anticancer effects, which are achieved by inhibiting the growth of cancer cells through induction of apoptosis and cell cycle arrest. The inhibition of pathways such as STAT3 and NF-κB by these compounds has been demonstrated to affect tumourigenesis [6].

In addition, ginger exhibits neuroprotective, cardioprotective, anti-obesity and anti-diabetic, antiemetic, analgesic, antimicrobial and immune system protective effects [7,8,9,10]. Ginger can also aid in the treatment of gastrointestinal diseases, such as ulcerative colitis, by acting as an anti-inflammatory and promoting wound healin [1]. Ginger is a valuable source of bioactive substances that, through their diverse mechanisms of action, support the health and treatment of many conditions. The most significant health-promoting activities are as follows:

1. Antioxidant activity

The main phenolic constituents of ginger, including gingerols, shogaols and paradols, exhibit potent antioxidant activity. These compounds activate the Nrf2 pathway, which in turn induces the expression of genes encoding antioxidant enzymes such as haem oxygenase-1 (HO-1) and NAD(P)H reductase (NQO1) [1,2, 20]. Furthermore, these compounds have been shown to protect cells from oxidative stress by reducing levels of reactive oxygen species (ROS) and preventing cellular damage.

2. Anti-inflammatory effects.

Ginger exhibits potent anti-inflammatory effects through the regulation of key signalling pathways in cells. Modulation of nuclear factor kappa B (NF-κB) and the PI3K/Akt pathway are among the main mechanisms by which ginger alleviates inflammation [1,2] . 6-Shogaol, which is one of the active compounds of ginger, inhibits the activation of NF-κB, resulting in reduced levels of pro-inflammatory cytokines such as TNF-α and IL-1β [17] . Furthermore, 6-shogaol blocks the PI3K/Akt pathway, which further supports the reduction of inflammatory processes in the body. Studies have indicated that ginger extracts can reduce inflammation in the gut and alleviate symptoms of colitis by inhibiting NF-κB activity and reducing interleukin-1 beta levels [23]. Consequently, the anti-inflammatory effects of ginger are multifaceted, involving both modulation of pro-inflammatory gene expression and direct effects on signalling pathways involved in inflammatory processes [22,25].

In addition, they have been shown to inhibit the activity of pro-inflammatory enzymes, such as cyclooxygenase-2 (COX-2), which may offer therapeutic benefits for a range of inflammatory conditions, including arthritis and heart disease [17]. The regular consumption of ginger has been shown to contribute to a reduction in pain and swelling associated with these conditions.

3. Antimicrobial activity

Ginger essential oil has antifungal effects by inhibiting fungal growth and aflatoxin production [36,37]. Ginger also shows inhibitory effects on the growth of bacteria, including Pseudomonas aeruginosa and Staphylococcus aureus. Gingerenone-A and 6-shogaol inhibit 6-

hydroxymethyl-7,8-dihydropterin pyrophosphokinase activity in bacteria. Ginger blocks the formation of bacterial biofilms by reducing levels of bis-(3′-5′)-cyclic dimeric guanosine monophosphate (c-di-GMP) [33,34,35,36,37].

Terpenes, such as zingiberene and α-curcumen, show the ability to inhibit the growth of pathogenic bacteria. The mechanism involves damage to bacterial cell membranes, leading to lysis and cell death. These compounds can also interfere with the metabolic processes of bacteria, which limits their ability to reproduce. Studies have shown that ginger essential oil is effective against various strains of bacteria, including Staphylococcus aureus and Escherichia coli, making it a promising natural antibacterial agent [36,37].

The terpenes present in ginger also have antifungal properties. For example, α-farnesene and β-sesquifelandrene show activity against pathogenic fungi such as Candida albicans. Their mechanism of action is to disrupt the integrity of the fungal cell membrane and inhibit their growth and development. The antifungal action of terpenes may be particularly important in the context of treating fungal infections and preventing their recurrence.

Terpenes from ginger may influence the immune system by modulating the immune response. They can stimulate the production of pro-inflammatory cytokines and activate immune cells, which supports the body in fighting infections [1,2]. This action may be beneficial in the context of both bacterial and fungal infections, as a stronger immune response may contribute to a faster fight against pathogens.

4. Anticancer effects.

Ginger inhibits the growth of cancer cells by inducing apoptosis (programmed cell death) and cell cycle arrest. 6-gingerol inhibits the STAT3 and NF-κB signalling pathways, which are often overactive in cancer cells [1,20,22,27]. In addition, 6-gingerol activates the p53 protein, which plays an important role in tumour suppression. In vitro studies have shown that 6-shogaol induces apoptosis in liver cancer cells, and 6-gingerol reduces tumour volume in a cervical cancer model [27].10-Gingerol inhibits proliferation of colon cancer cells. [6]

5. Neuroprotective effects

Ginger has been shown to have neuroprotective properties, protecting nerve cells from damage caused by oxidative stress and inflammation. Compounds such as 6-shogaol may inhibit the loss of dopaminergic cells, which may be important in the prevention and treatment of neurodegenerative diseases such as Parkinson's disease [7].

Ginger protects against neurodegenerative diseases by alleviating inflammation in the nervous system and improving cognitive function. Studies have shown that 6-shogaol can inhibit dopaminergic cell loss induced by toxins such as MPP+. By reducing oxidative stress and

inhibiting inflammatory processes, ginger may protect against neurodegenerative diseases. Administration of 6-shogaol improves motor coordination and alleviates bradykinesia in mice with induced MPTP lesions [10].

6. Cardioprotective effects

Ginger has been shown to have beneficial effects on the cardiovascular system by reducing cholesterol and triglyceride levels [6]. Gingerols and shogaols have been shown to impact lipid metabolism by inhibiting the activity of cholesterol ester transfer protein (CETP). Furthermore, 6-gingerol has been shown to possess vasodilatory properties, thereby enhancing vascular endothelial function and regulating blood pressure. [10]

7. Anti-obesity and anti-diabetic effects

Ginger may assist in the treatment of obesity and type 2 diabetes by improving insulin sensitivity and increasing glucose metabolism. Compounds such as 6-paradol and 6-shogaol activate the protein kinase AMPK, leading to reduced blood glucose levels and improved lipid metabolism. In addition, ginger can inhibit adipogenesis, the process of creating new fat cells [10, 21].

8. Antiemetic effects

Ginger is particularly valued for its anti-emetic properties. Studies have shown that it can effectively relieve nausea and vomiting associated with pregnancy, motion sickness and chemotherapy. It affects the nervous system, which reduces the sensation of nausea. Ginger's mechanism of action is to block the 5-HT3 receptors, which are responsible for inducing nausea. [28]. Ginger is an effective and safe herbal remedy for decreasing nausea and vomiting during pregnancy [29].

9. Analgesic effects

The analgesic effect of ginger has been demonstrated in a number of studies. Clinical studies have confirmed that the ingestion of ginger can reduce the intensity of menstrual pain and alleviate joint discomfort. A meta-analysis of clinical trials has shown that ginger is effective in reducing the intensity of menstrual pain. In a particular study, the ingestion of 500 mg of ginger, three times a day for a period of five days, was demonstrated to result in a significant reduction in the intensity of menstrual pain [30].

CONCLUSION

Ginger is a valuable source of bioactive compounds with a wide range of health-promoting activities. A number of its activities such as antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, cardioprotective, analgesic, anti-obesity and anti-diabetic are the basis of ginger's use in medicine. With its complex action at the molecular level, modulating

inflammatory processes, protecting against oxidative stress, inhibiting tumor growth and supporting the treatment of gastrointestinal and microbial diseases, it holds promise for the treatment of many diseases.

Ginger is a natural remedy with numerous health-promoting properties that stands out for its high availability, affordability and ease of use. Its minimal risk of side effects makes it an attractive option for those seeking natural methods of supporting health and treating various ailments, especially for pregnant women or chronically ill people with complex drug treatment. Regular consumption of ginger can provide many health benefits, making it a valuable addition to the daily diet.

Disclosure

Author's contribution:

Conceptualisation: AM, BU

Methodology: WF, AD

Software: AF, AK

Check: JRD, JL

Formal analysis: AM, MJ

Investigation: MN, AK

Resources: BU, JL

Data curation: MJ, WF

Writing-rough preparation: JRD, AD

Writing review and editing: AF, AM

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