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Review

Ginger's nutritional implication on gastrointestinal health

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ABSTRACT

Background and Aims: Ginger is a root that is high in nutritional and bioactive compounds that offer significant health benefits. Ginger has been used for centuries in traditional and alternative medicine to aid digestion, reduce nausea and provide other gastro-protective benefits. This review aims to summarize ginger's nutritional implications on gastrointestinal health and to update the current developments.

Methods: Clinical trials published in English were searched in PubMed, Scopus, EMBASE and Cochrane Central Register of Controlled Trial databases with keywords from inception to December 2023. The search protocol was performed under the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA,2009) guidelines. Due to the small sample size and the heterogeneity of studies, a narrative synthesis without meta-analysis is reported.

Results: In the current review, evidence of ginger's nutritional implications on gastrointestinal health is reported. A daily dose of 2000 mg of ginger is beneficial for reducing dyspepsia, colorectal cancer, bowel disorders and gastric ulceration in the digestive tract of patients with gastrointestinal disorders. Because of the heterogeneity and limited number of studies, the results may not be as powerful as finding significant results.

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Conclusions: Despite the small number of studies and the large heterogeneity, the majority of the studies have shown ginger's nutritional implications on gastrointestinal health.
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Introduction

The perennial herb ginger (Zingiber officinale) is a member of the Zingiberaceae family. Although it originated in Southeast Asia, it is currently widely grown throughout the world, especially in China, India, and Jamaica. Since ancient times, ginger has been used both medicinally and as a diet, and it is a common element in many different cuisines worldwide. There are several ways to eat ginger: it can be eaten raw, dried, powdered, or made into juice or oil [1]. The portion of the ginger plant that is most frequently utilized is the root. It smells strong and has a flavor that is pungent and spicy. Ginger is a common flavoring ingredient in cooking, particularly in Middle Eastern, Asian, and Indian dishes. Moreover, it is utilized to make ginger tea, a widely consumed beverage worldwide [2]. Ginger has been used medicinally for extensive time in addition to its culinary purposes. It has long been used to treat a variety of illnesses, such as inflammation, nausea, and digestive problems. Additionally, studies have demonstrated the anti-inflammatory, anticancer, and antioxidant qualities of ginger [3] (Tables 1 and 2).

In Europe, ginger is not native but has been imported and used in European cuisine and medicine for centuries. The use of ginger in Europe dates to the Middle Ages when it was highly valued for its medicinal properties and is used to treat a variety of ailments, including digestive issues, joint pain and respiratory infections. Currently, ginger is a widely used spice in European cuisine and is used to flavor sweet and savory dishes. Gingerbread is a popular sweetener that is traditionally associated with Christmas and other winter holidays in many European countries, while ginger is also used in savory dishes such as curries, stir-fries, and marinades [4]. In terms of medicinal use, ginger has been studied for its potential health benefits in Europe, and there is a growing body of scientific evidence supporting its use for various conditions [5].

The nutritional and bioactive constituents of ginger

The possible health benefits of ginger are attributed to several chemical and nutritional components. The flavor and aroma of ginger are mostly attributed to a few major chemicals, such as gingerols, shogaols, zingerone, and paradols. Additionally, ginger contains several vitamins and minerals, such as manganese, magnesium, and vitamin B6. The following are a few studies that examined the nutritional and chemical components of ginger:

Gingerols: The main bioactive component of ginger, gingerols, gives it a strong flavor and scent. Research has indicated that gingerols have anti-inflammatory and antioxidant properties. A study published in the Journal of Agricultural and Food Chemistry suggested that the presence of gingerols may reduce the production of inflammatory cytokines by human immune cells [6]. According to a review, gingerols have potent antioxidant activity and can reduce oxidative stress [7]. According to a published study, shogaols can lower the production of inflammatory cytokines in human immune cells and have anti-inflammatory effects. In addition, gingerol also observably inhibited LPS-induced TNF-α, IL-1β, IL-6, and PGE_2 ($p < 0.01$) expression and secretion in a dose-dependent manner. At the genetic level, after the intervention of gingerol, mRNA transcriptions of iNOS, COX-2, IL-6, and IL-1β were all decreased. The protein expressions of iNOS, NF-κB, p-p65, and p-IκB were significantly increased in LPS-induced cells, while these changes were reversed by the treatment with gingerol in which it suggested that gingerol exerts its anti-inflammatory activities in LPS-induced macrophages which can inhibit the production of inflammatory cytokines by targeting the NF-κB signaling pathway [8]. Shogaols have been shown in

Table 1
Effect of ginger on gastrointestinal disorders

Reference	Study design	Symptom/ disease type	Intervention	Comparator	Duration	Main results	Adverse effects
Nikkhan Bodaghi *et al.* [25]	RCT	IBD	2000mg ginger	Maltodextrin powder capsule	12 weeks	• Reduced MDA • Improved SCCAI, IBD-Q • No difference in TCA, total anti-oxidant capacity	Yes
Van Tilberg *et al.* [26]	RCT	IBS	1000, 2000 mg ginger	Brown sugar in capsules	4 weeks	Reduction in IBS-SSS with placebo and 1gm ginger	Yes
Van Tilberg *et al.* [26]	RCT	IBS	1gm of ginger in capsules (2.29mg gingerols and 6-shogols)	Brown sugar in capsules	28 days	No evidence for better improvement of ginger in the treatment of IBS	Yes
Abass An [27]	RCT	IBD	2000mg of ginger in 4 capsules	Placebo	12 weeks	Serum MDA, Serum TFN-ά levels and levels hs-CPR, the quality of life was increased after ginger use	
Nikkhan Bodaghi *et al.* [25]	RCT	IBD	500mg/day of dried ginger powder in four capsules	Maltodextrin powders	6 weeks	No important changes in quality of life and inflammatory factors	
Jun *et al.* [28]	RCT	IBD	Two groups Group 1= live combined bifidobacterium lactobacillus and enterococcus capsules orally Group 2= live combined bifidobacterium lactobacillus and enterococcus capsules orally with acupuncture umbilical ring point ginger partition		4 weeks	The IL-8 and TNF-ά serum levels were lowered in both groups	

Abbreviations: IBS= Inflammatory bowel syndrome IBD=Inflammatory bowel disease UC= ulcerative colitis; MDA= malon-dialdehyde; TNF-α; tumor necrosis factor IL-8= Interleukin-8; CRP= Reactive protein; SCCAI= simple clinical colitis activity index IBD-Q= inflammatory bowel disease questionnaire; IBS-SSS: - IBS severity scoring system.

another study to possess strong anticancer properties and the ability to cause cancer cells to undergo apoptosis or cell death [9]. Another key component of ginger that gives it its fiery flavor is zingerone. In addition to its anti-inflammatory, antidiabetic, and antioxidant effects, it may also help prevent liver damage and lessen nausea. Research has demonstrated that zingerone can lower human immune cell production of inflammatory cytokines [10]. According to animal study published in the Journal of Nutritional Biochemistry, zingerone can lower blood sugar levels and increase insulin sensitivity in diabetic rats [11]. The biological effects of paradols, another component of ginger, are comparable to those of gingerols and shogaols and include antioxidant and anti-inflammatory properties. They might also aid in lowering cancer risk and enhancing insulin sensitivity. It was reported that paradols have potent antioxidant activity and can protect against oxidative stress [12,13].

Table 2
Effect of ginger on gastrointestinal disorders

Reference	Study design	Symptom/ disease type	Intervention	Comparator	Duration	Main results	Adverse effects
Phillips *et al.* [40]	RCT	Gastric emptying	500mg powdered ginger/cup, 2 capsule/dose	500mg of lactose/capsule, 2 capsule/dose		Ingestion of 1gm of ginger simultaneously with paracetamol did not affect the rate of absorption of paracetamol. Thus the study revealed that ginger had no better effect on gastric motility	
Zick *et al.* [41]	RCT	Patients with a high risk for colorectal cancer	250mg of dry ginger root extract	250mg lactose capsule, 8 capsules/day	28 days	It significantly decreased risk in the normal colonic mucosa of arachidonic acid and significantly increased LTB4, but other eicosanoids were ineffective.	No
Zick *et al.* [42]	RCT	Patients with a normal risk for colorectal cancer	250mg of dry ginger root extract	250mg lactose capsule, 8 capsules/day	28 days	Ginger supplementation can help to reduce eicosanoid levels by inhibiting synthesis from arachidonic acid	No
Citronberg *et al.* [43]	RCT	Colorectal cancer	250mg of dry ginger root extract	A lactose powder of 250mg/cap, 8 capsules//day	28 days	Two grams of ginger extract may help in reducing the proliferation of normal-appearing colorectal epithelium and increase apoptosis and differentiation relative to proliferation.	Yes
Jiang *et al.* [44]	RCT	Normal risk for colorectal cancer	250mg of ginger extract/ cap, Capsules/ day	Placebo, lactose	28 days	In the high risk colorectal cancer participants, the colonic cyclooxygenase-1 protein level significantly decreased in the ginger group. In contrast 15-hydroxyprostaglandine was unchanged. No significant difference in average risk between the ginger group and placebo groups.	No
		High risk for colorectal cancer	250mg of ginger extract/ cap, 8 Capsules/ day	Placebo, lactose	28 days		

In terms of nutritional constituents, ginger is also a good source of several important vitamins and minerals [14]. The pleasant aroma of ginger is caused by more than 70 constituents present in the steam volatile oil, and the active ingredients of ginger are believed to be present. The geographic origin and growing conditions have an impact on the chemical composition of essential oils. Nevertheless, the primary component, sesquiterpene hydrocarbons, which are responsible for the scent, appears to be nearly constant [15]. Ginger is a low-calorie root herb that is rich in various nutrients and has potential

health benefits. The following are some of the investigated nutritional constituents of ginger: please see Figure 1 for more information.

Carbohydrates: Ginger is a good source of carbohydrates, providing approximately 17 grams of carbohydrates per 100 grams of fresh ginger. These carbohydrates include simple sugars such as glucose and fructose, as well as complex carbohydrates such as starch. Fiber: Ginger is also a good source of dietary fiber, providing approximately 2 grams of fiber per 100 grams of fresh ginger [15]. Fibers have been shown to have numerous health benefits, including promoting digestive health, reducing the risk of heart disease and aiding in weight management. Ginger is also a good source of several vitamins and minerals, including vitamin C, potassium, magnesium, and copper. Vitamin C is a powerful antioxidant that helps to protect cells from oxidative damage, while potassium is important for maintaining healthy blood pressure and heart function [15].

Rational for conducting the review

The rationale for conducting this review on ginger's nutritional implications for gastrointestinal health stems from the growing interest in natural remedies and dietary interventions for promoting digestive wellness. Ginger has been traditionally used for its purported benefits on digestion, and numerous studies have investigated its potential effects on gastrointestinal health. However, the existing body of evidence may be fragmented or inconclusive, necessitating a comprehensive review to synthesize and evaluate the available literature. Thus, the rationale for conducting a review would likely involve synthesizing and evaluating existing evidence to provide a comprehensive understanding of ginger's role in promoting gastrointestinal health. This review could help identify gaps in knowledge, clarify inconsistencies in findings, and provide recommendations for future research or clinical applications.

Methods

Search strategy

Two independent researchers searched systematically for clinical trials in English in were searched in PubMed, Scopus, EMBASE and Cochrane Central Register of Controlled Trial databases with keywords: “Zingiber officinale” OR “Z. officinale” OR “Ginger” AND “Nutritional implication” AND “Gastrointestinal”. Data were collected up to December 2023 and regularly updated by manual search. The search protocol was performed under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2009) guidelines and registered in PROSPERO. Registration number: CRD42022378544.

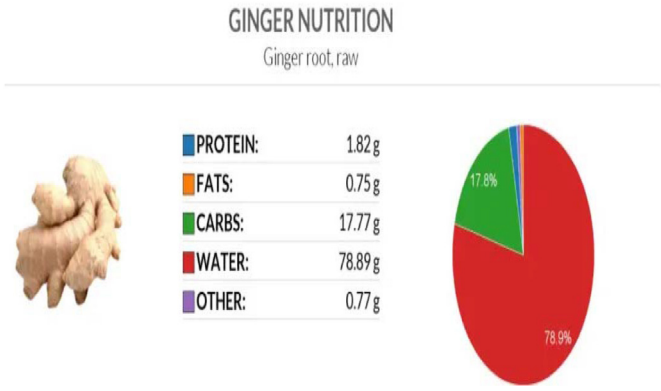

Figure 1. 'Nutritional contents of ginger per 100g, Source Food and Drug Administration (FDA).

Inclusion criteria

All clinical trials conducted concerning the impact of ginger supplementation on gastrointestinal diseases were encompassed.

Exclusion criteria

Studies with the following criteria were excluded: studies without a control group, studies involving pregnant women, studies involving children, gray literature and case reports. We also exclude inappropriate articles like not related topics; irrelevant data for analysis; secondary analysis; unavailable abstract or full-text; duplicate articles; and letters, commentaries, and meeting records.

Data extraction and analysis

Clinical trial studies and interventions involving the use of ginger were included. Data from studies that met the inclusion criteria were extracted according to author name, study design, symptom or type of disease, intervention, comparator duration, and main results obtained. Due to the small sample size and the heterogeneity of the studies, a narrative synthesis without meta-analysis was reported.

Results

A total of 5952 articles were identified and screened. After screening, a total of 289 articles were chosen for full-text articles. A final total of 13 articles were included Figure 2.

Characteristics of the studies.

There was large heterogeneity in terms of the symptoms of the disease, study design, dose of the supplement and duration.

Discussion

Effect of ginger supplementation on gastrointestinal disorders

Ginger has been used for centuries as a natural remedy for various gastrointestinal disorders, and there is scientific evidence to support its use. Several studies like RCTS and systematic reviews have showed the effects of ginger on gastrointestinal diseases:

Effects of ginger on IBS and IBD

Irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD) are two different gastrointestinal conditions that have certain similar symptoms. The symptoms of irritable bowel syndrome (IBS), a common gastrointestinal ailment, include bloating, abdominal pain, and altered bowel patterns. Ginger has long been used as an all-natural treatment for several digestive tract conditions, such as IBS and IBD [16]. The following research has investigated how ginger affects IBS. A study that was conducted on an evaluation of ginger's effectiveness in treating IBS showed that compared with a placebo, ginger considerably decreased the intensity of IBS symptoms, such as stomach pain, bloating, and gas, in 452 participants in randomized controlled studies [16]. Similarly, a study showed that ginger was well tolerated and did not cause any notable side effects [17]. The effectiveness of ginger in treating IBS was assessed in a second systematic review and meta-analysis that was carried out and published in the journal Evidence-Based Complementary and Alternative Medicine in 2018. The analysis examined 12 randomized controlled studies with 811 IBS patients in total. Its key findings showed that ginger, when compared to a placebo, significantly decreased the symptoms of IBS, such as bloating, diarrhea, and frequent stools. All the studies revealed no notable adverse effects, and ginger was well tolerated. In this review, the optimal dose and duration of ginger supplementation for IBS patients are still unclear, and additional high-quality studies are needed to determine the long-term safety and efficacy of ginger in the treatment of IBS [18].

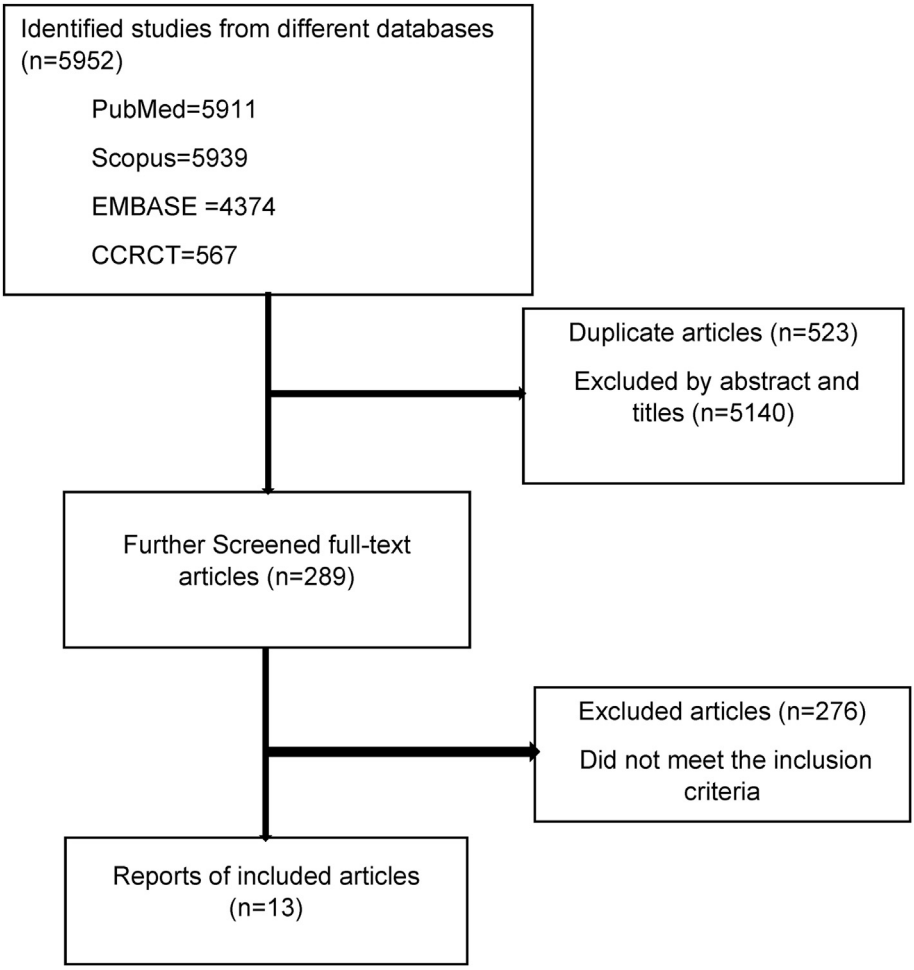

Figure 2. Flowchart of the search and selection process.

In addition, a randomized double-blind placebo-controlled trial published in 2014 evaluated the effect of ginger on IBS symptoms. This study involved 70 patients with IBS and compared the effects of ginger and placebo on IBS symptoms for 28 days. The key findings of the study showed that ginger significantly reduced overall IBS symptoms and improved quality of life compared to a placebo. Ginger also improved specific IBS symptoms, including bloating, abdominal pain, and gas. The study concluded that ginger is a safe and effective natural treatment option for IBS symptoms [19]. Another randomized double-blind placebo-controlled trial published in the Journal of Clinical Gastroenterology in 2014 evaluated the effect of ginger on IBS symptoms. This study involved 150 patients with IBS and compared the effects of ginger and placebo on IBS symptoms for 28 days. It has been reported that ginger significantly reduces overall IBS symptoms compared to a placebo. Ginger also improved specific IBS symptoms, including abdominal pain and bloating. The study concluded that ginger may be a useful treatment option for IBS patients with mild to moderate symptoms [20].

Overall, these studies suggest that ginger may be a promising natural treatment option for IBS. Ginger appears to be effective in reducing IBS symptoms, including abdominal pain, bloating and stool frequency, as well as improving the quality of life of IBS patients. Ginger has also been found to be well tolerated and safe, with no significant adverse effects as it is reported in a study. However, it is

important to note that the optimal dose and duration of ginger supplementation for IBS patients are still unclear, and additional high-quality studies are needed to determine the long-term safety and efficacy of ginger in the treatment of IBS. Additionally, gastrointestinal disease, inflammatory bowel disease (IBD), is a chronic and debilitating condition that affects the digestive tract. Several studies have investigated the effects of ginger on IBD in both animal and human models. For instance a study revealed that ginger supplementation reduced inflammation and oxidative stress in a rat model of colitis, a form of IBD [21]. Ginger extract decreased inflammation and enhanced the composition of the gut microbiota in a rat model of ulcerative colitis [22]. Other research has examined the impact of ginger on inflammatory bowel disease (IBD). For example, a pre-clinical study revealed that ginger extract decreased inflammation in a colitis-affected mouse model by controlling the immune response [23]. A human study revealed that supplementation with ginger lowered inflammatory markers and enhanced quality of life in patients with ulcerative colitis, another type of IBD [24].

In conclusion, while further research is needed to fully understand the effects of ginger on IBD, the existing evidence suggests that ginger may have anti-inflammatory and antioxidant properties that could benefit individuals with this condition. Overall, while more research is needed to fully understand the potential therapeutic effects of ginger on IBD, the existing evidence suggests that ginger may have promise as a complementary treatment option for this condition. The mechanisms underlying the potential therapeutic effects of ginger on IBD are not yet fully understood. However, it is believed that the anti-inflammatory and antioxidant properties of ginger may play a role in reducing the inflammation and damage caused by IBD [17].

Effects of ginger on gastric emptying and dyspepsia

Ginger has been found to have a positive effect on gastric emptying, which is the process by which food leaves the stomach and enters the small intestine. Several studies have investigated the effects of ginger on gastric emptying, with varying results.

In patients with functional dyspepsia, ginger considerably sped up stomach emptying compared to that in a placebo group, according to a previous study [29]. Similarly, a comprehensive review and meta-analysis published in the journal Complementary Therapies in Medicine revealed that, compared to patients in a placebo group, patients with dyspepsia who consumed ginger experienced a substantial increase in stomach emptying [30]. Ginger extract improved stomach emptying in healthy volunteers, according to a different study published in the European Journal of Gastroenterology and Hepatology [31], but only when it was used in large amounts. Another study revealed that in healthy participants, taking a ginger supplement had no discernible impact on stomach emptying [32,33]. In a different study, it was discovered that taking supplements containing ginger greatly accelerated stomach emptying and delayed it in individuals with functional dyspepsia [29]. In general, while the evidence is not entirely consistent, a growing body of research suggests that ginger may have a positive effect on gastric emptying in various populations, including those with dyspepsia, diabetes-related gastroparesis and chemotherapy-induced nausea.

Bloating, early satiety, and upper stomach pain or discomfort are the hallmarks of dyspepsia. Several clinical investigations have investigated the possible effects of ginger on dyspepsia. Compared with placebo, ginger was proven to considerably reduce dyspepsia symptoms in a double-blind, randomized study [29]. Similarly, a meta-analysis published in the Journal of Gastroenterology and Hepatology revealed that compared with a placebo, ginger significantly lowered patients' dyspepsia symptoms [34]. Compared with patients in the placebo group, patients with functional dyspepsia who consumed ginger experienced a significant reduction in dyspepsia symptoms, according to a different published study [29]. Compared to a placebo, a combination of ginger and artichoke extract dramatically reduced dyspepsia symptoms according to randomized controlled research [35].

Use of ginger for gastric ulcerations

Ginger has been investigated for its antiulcer effects on gastric ulcers, which are sores or lesions that develop in the lining of the stomach. The most common causes of gastric ulcers are infection with the bacterium *Helicobacter pylori* and long-term use of nonsteroidal anti-inflammatory drugs (NSAIDs). Ginger contains several bioactive compounds, including gingerols and shogaols, which may have anti-

inflammatory and antioxidant properties. Ginger has been shown to have a protective effect against gastric ulcers by increasing mucus secretion, reducing inflammation, and inhibiting the growth of *Helicobacter pylori* bacteria, which are common causes of gastric ulcers.

Several researchers have investigated the impact of ginger on stomach ulcers. Researchers discovered that supplementation with ginger dramatically decreased the size and severity of stomach ulcers in rats in a randomized, double-blind, placebo-controlled clinical trial that was published in the Journal of Ethno Pharmacy in 2015. The authors proposed that the protective effects of ginger on the lining of the stomach could be attributed to its antioxidant and anti-inflammatory qualities [36]. Another study investigated how ginger extract affects stomach ulcers in mice. The severity of gastrointestinal damage caused by NSAIDs and the development of ulcers were both considerably lessened by the ginger extract. The scientists concluded that ginger extract might be useful in treating and preventing stomach ulcers [37].

The effects of ginger on stomach ulcers were examined using data from 12 randomized controlled trials in a comprehensive review and meta-analysis. They discovered that taking supplements containing ginger greatly lowered the incidence of stomach ulcers and the intensity and duration of ulcer symptoms. According to the authors, ginger may be a natural remedy for stomach ulcers that is both safe and efficient [38]. A more recent randomized clinical study examined the impact of ginger powder on the healing of stomach ulcers in human patients infected with *H. pylori*, and the results were published in the Journal of Ethnopharmacology in 2021. Researchers discovered that, when compared to the control group, the treatment group's symptoms were much better, and the pace at which gastric ulcers healed was significantly greater when ginger powder was supplemented [39].

In summary, multiple studies have suggested that ginger may have potential nutritional preventive and therapeutic efficacy on gastrointestinal health, likely due to its anti-inflammatory and antioxidant properties. Nevertheless, further research is needed to deeply determine the optimal dose and duration of ginger supplementation.

The mechanism of action of ginger in gastrointestinal diseases

Ginger is a root with various potential health benefits, including effects on gastrointestinal (GI) abnormalities such as nausea, vomiting, dyspepsia and gastric ulcers. The bioactive and nutritional compounds in ginger, including gingerols, shogaols, and zingerone, are thought to exert these effects through several mechanisms of action.

Anti-inflammatory effects: Inflammation can cause a range of GI abnormalities, including nausea, vomiting, and dyspepsia. Gingerols and shogaols in ginger have been shown to have anti-inflammatory effects by inhibiting the production of proinflammatory cytokines and other inflammatory mediators. This can help reduce inflammation in the GI tract and alleviate the symptoms of GI abnormalities. Studies suggest that ginger has anti-inflammatory effects on the gastrointestinal tract, which could be beneficial for treating conditions such as inflammatory bowel disease, gastritis and gastric ulcers. The anti-inflammatory properties of ginger are thought to be due to its ability to inhibit the production of proinflammatory cytokines, such as TNF-alpha and IL-1 beta, and enzymes, such as COX-2, which are involved in inflammation. Additionally, ginger contains compounds called gingerols and shogaols that have been shown to have antioxidant and anti-inflammatory effects. These compounds may also help to protect against oxidative damage and inflammation in the gastrointestinal tract [5,45].

Studies have shown that TNF-a, NF-kB, i-NOS, and COX-2 and enhanced production of proinflammatory eisonaoids are key mediators of inflammation and play crucial roles in several pathophysiological processes [46]. Studies on ginger and its components have revealed that they limit prostaglandin synthesis by inhibiting COX-1 and COX-2 as well as leukotriene biosynthesis by inhibiting 5-LOX [47]. [5]. The phytochemicals 8-paradol and 8-shogaol have potent inhibitory effects on COX-2 enzyme activity in vitro [48]. Research on ginger and its phytochemicals has also revealed that they can lower NF-kB expression and the levels of proinflammatory cytokines (TNF-a, IL-1b, IL-6, and interferon-g) [49]. To fight *H. pylori* infection, ginger extract suppressed the activity of COX-2 and NF-kB as well as the production of IL-1b, IL-6, IL-8, and TNF-a from LPS-stimulated human peripheral blood mononuclear cells [50].

Ginger also modulates muscarinic and 5HT receptors and enhances gastric motility. Muscarinic receptors (M1 and M2) and 5HT are integral parts of the enteric nervous system and influence gastrointestinal motility. The hydromethanolic extract of dried ginger was successful in reversing spasmogenic effects, according to in vivo studies on the fundus of the rat stomach [51]. Studies have also revealed that ginger has a calcium-antagonistic effect that causes spasmolysis. By decreasing the gastric emptying time and the amount of time that acidic gastric contents are in contact with the mucosa, increased spasmolytic activity protects against potential gastric injury and ulcerogenesis [52]. Additionally, ginger encourages the production and release of mucin, a buffer that protects the pyloric end of the stomach's walls from the corrosive effects of hydrochloric acid. Taken together, these findings suggest that ginger has gastro-protective effects through activating muscarinic receptors and blocking 5-HT (3) receptors.

Other ginger ingredients, 6-gingerol and zingerone, have been shown to inhibit lipid peroxidation in vitro. Polyphenols block the absorption of lipotoxic MDA into the bloodstream and reduce lipid peroxidation in food, both of which prevent atherogenesis. Ginger may work through this method to provide additional benefits to the person while still protecting the stomach and circulatory system [53].

Limitation

This Review has some limitations:

- The search only included studies conducted in the English language. This could result in the omission of relevant studies, particularly those published in non-English languages.
- Narrative reviews lack a structured approach to finding and analyzing evidence, risking the omission of important studies.
- The limited number of studies available might limit the certainty of the evidence of this review.
- There subjectivity nature in narrative reviews might introduce bias on our interpretations
- Narrative reviews often lack quantitative analysis, hindering the assessment of evidence strength.
- Due to the nature of narrative reviews, presence of insufficient quality assessment methods, may result in the inclusion of studies with varying rigor, compromising review validity.

Conclusions

Despite the small number of studies and the large heterogeneity, the majority of the studies have shown ginger's nutritional implications on gastrointestinal health. Ginger's nutritional and bioactive components' as an adjuvant in the of gastrointestinal disorders have been shown to decrease inflammation and oxidative stress in Irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), dyspepsia, gastric ulcers and other gastrointestinal disorders. This could be due to the bioactive compounds in ginger, in which ginger have been shown to inhibit the production of pro-inflammatory cytokines such as interleukin-1 beta (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) by downregulating NF-κB activation and demonstrated potent anti-inflammatory effects by inhibiting COX-2 expression and prostaglandin E2 (PGE2) production in various cell and animal models of inflammation. Ginger extracts can also enhance the activity of endogenous antioxidant enzymes such as superoxide dismutase (SOD) and glutathione peroxidase (GPx), further contributing to its antioxidative effects. However, due to the limited number of studies on ginger's nutritional implication on gastrointestinal health and some inconsistencies, more controlled clinical trials with different dosages and duration are needed to obtain a firm conclusion.

Author contribution

Lemlem Gebremariam Aregawi, conceptualized, conducted a literature review, designed the methodology, performed data collection and statistical analysis, drafted the initial manuscript, data

interpretation, wrote the manuscript, edited and reviewed the manuscript read and agreed to publish the manuscript. **Csiki Zoltan:** Supervision, conceptualized the research, designed the methodology, supervised the data collection and analysis, conducted the literature review, performed the statistical analysis, drafted the initial manuscript, data interpretation, wrote the manuscript, edited and reviewed the article, read and agreed to publish the manuscript.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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