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SHORT REVIEW

Healing the Gut Naturally: Exploring Herbal Remedies for Functional Gastrointestinal Disorders

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Abstract

Background: Chronic digestive symptoms without discernible anatomical abnormalities are the hallmark of Functional Gastrointestinal Disorders (FGID), which include Gastroesophageal Reflux Disease (GERD), Functional Dyspepsia (FD), and Irritable Bowel Syndrome (IBS). Their aetiology is complex and includes immunological activation, microbial imbalance, visceral hypersensitivity, gut-brain axis dysfunction, and psychosocial variables. The development and course of symptoms are significantly influenced by ion channels and brain signalling pathways. Because these illnesses are complicated and overlapping, conventional treatments frequently fail. **Aim:** This review explores the therapeutic potential of selected herbal remedies—fennel, cumin, ginger, aloe vera, chia, cinnamon, and licorice-for managing FGID. **Methods:** A comprehensive review of recent experimental, clinical, and mechanistic studies was conducted to evaluate the pharmacological actions, bioactive compounds, safety, and traditional use of these botanicals relevant to FGID. **Results:** These remedies possess several multi-targeted actions, like anti-inflammatory, antioxidant, neuroregulatory, and microbiota-modulating effects. Their bioactive substances help to relieve symptoms and maintain gut homeostasis by acting on important biological pathways such as COX-2, PGE2, 5-HT signalling, Signal Transducer and Activator of Transcription (STAT), and tight junction integrity. The historic use, safety, and effectiveness of these botanicals make them a suitable adjunct to FGID treatment. To incorporate them into mainstream therapy, however, more clinical validation, standardisation, and individualised use are required. **Conclusion:** Herbal remedies such as fennel, cumin, ginger, aloe vera, chia, cinnamon, and liquorice offer promising multi-targeted therapeutic effects for FGIDs. However, further clinical trials, standardisation of formulations, and personalised treatment approaches are necessary to establish their efficacy and integrate them into routine clinical practice.

Major Findings: This review highlights the use of herbal remedies in the management of functional gastrointestinal disorders, with an emphasis on their relevance to the various underlying pathophysiological aspects. It underscores their potential role as safe and effective adjuncts to conventional treatments.

Keywords: Aloe Vera, Fennel, Functional Gastrointestinal Disorders, Ginger, Gut-Brain Axis, Visceral Hypersensitivity

1. Introduction

GERD, IBS and FD are examples of FGID, a group of chronic conditions marked by recurrent and persistent digestive symptoms that lack any discernible structural, biochemical, or metabolic abnormalities. These illnesses rank among the most common gastrointestinal disorders, impacting millions of people worldwide and severely lowering daily functioning and general quality of life. Abdominal pain, bloating, abnormal bowel habits, nausea, early satiety, and reflux sensations are common symptoms of FGIDs that can be made worse by dietary, stress, and psychological factors[1]. FGID are complicated, multisystem illnesses that include changes in GI secretion, motility, feelings, and central perception. The diagnosis of FGIDs is particularly difficult due to the lack of a characteristic histological phenotype, which also suggests that the pathophysiology may be molecular. This notion is supported by research showing that FGIDs have a heritable genetic component[2,3].

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For ages, herbal medicines have been a crucial component of traditional medicine in many countries, providing completely organic remedies for a variety of illnesses, including FGIDs. In situations where traditional medicines would not be sufficient, their use has continued, both as prescription alternatives and as home remedies[4-6]. Herbal medicines are especially regarded for their multi-component mechanisms, which enable them to effectively address the overlapping and complicated symptoms of FGID[7,8]. In certain countries, these treatments are recommended by therapy guidelines. They offer a desirable substitute with few adverse effects and are safe for extended use.

2. Pathophysiology

Some interrelated processes, including visceral hypersensitivity, poor gut-brain axis signalling, dysregulated intestinal motility, altered immunological responses, and abnormalities in the gut microbiota, are part of the extremely complex and multifactorial pathophysiology of FGID[9]. According to new research, gut dysbiosis, which is defined by an imbalance between pathogenic and helpful microbes, plays a critical role in the development of disease by influencing intestinal permeability, inflammation, and neurotransmitter function. Persistent symptoms are also caused by low-grade inflammation and immunological activation, which are frequently brought on by infections, dietary variables, or reactions to stress. Moreover, genetic predisposition and epigenetic modifications have been linked to FGID susceptibility, affecting gene expression patterns related to neurotransmission, gut motility, and immune regulation[10]. Social psychology factors, like anxiety, depression, and stress, further exacerbate symptom severity by influencing autonomic nervous system function and stress-related pathways. FGID have a complicated, multifaceted aetiology that involves multiple important mechanisms.

2.1 Gut-Brain Axis Dysregulation

FGID are classified as disorders of the brain-gut connection, emphasising the intricate and reciprocal interaction between the intestinal tract (GI tract) and the Central Nervous System (CNS). Communication breakdowns between the GI tract and CNS are often linked with FGID. The pathogenesis of FGID revolves around the dysregulation of this axis, which includes low-grade inflammation, stress-induced hormonal changes, dysbiosis of the gut microbiota, neurotransmitter imbalances (e.g., serotonin impacting gut motility), and poor vagus nerve signalling. These elements work together to cause chronic gastrointestinal discomfort, increased visceral sensitivity, and altered motility[11].

2.2 Visceral Hypersensitivity

Visceral Hypersensitivity (VH) is an essential process in the pathophysiology of FGID, such as IBS. It causes pain as well as discomfort by causing the Gastrointestinal (GI) system to react more strongly to typical physiological stimuli. Central and peripheral sensitisation, in which the gut's nerve endings and central nervous system become too reactive, is the cause of this increased sensitivity. The heightened sense of discomfort is caused by changes in pain-signalling pathways, disruption of the brain-gut axis, and neuroimmune interactions. VH is a trademark of FGID, as psychological variables such as stress and worry exacerbate the illness[12,13].

2.3 Altered Gut Microbiota

The GI tract's varied collection of bacteria, known as the gut microbiota, affects immunological response, gut-brain connection, and digestion. These functions can be upset by a disturbance in the gastrointestinal microbes' makeup, which may result in symptoms including discomfort, gas, and changed stool habits. The symptoms of FGID are made worse by dysbiosis, which also impairs gut motility, increases intestinal permeability (also known as "leaky gut"), and causes low-grade inflammation. Furthermore, gut-brain communication is impacted by metabolites produced by bacteria like fatty acids with short chains, which can also lead to mood disorders that are frequently linked to FGID[14,15].

2.4 Low-grade Inflammation

It involves immunological activity in the gastrointestinal system that is modest but chronic, which might interfere with normal gut processes. Increased intestinal permeability is associated with this chronic inflammation, which permits immune cells to be activated by luminal antigens. Gut motility

is hampered, and visceral hypersensitivity is made worse by pro-inflammatory cytokines and mediators. Furthermore, psychological stress and microbial imbalances (dysbiosis) can exacerbate symptoms like pain, bloating, and changed bowel habits in FGID by contributing to this inflammatory state[16].

2.5 Psychosocial Factors

The gut-brain axis can be upset by emotional stress, worry, and depression, which can change how the gastrointestinal tract moves and how pain is perceived. These mental states frequently intensify indications like gas, stools that are not regular, and stomach pain by amplifying visceral hypersensitivity. Psychosocial stress also affects immunological responses and the composition of the microbes in the gut, which leads to low-grade inflammation as well as dysbiosis. These elements work together to produce a feedback loop that worsens the general quality of life and prolongs FGID symptoms[17,18].

3. Herbal Remedies for the Treatment of FGID

Herbal remedies stand out due to their ability to target multiple mechanisms simultaneously, thanks to their diverse active components. Herbal treatments can target some underlying reasons that contribute to FGID, including inflammation and problems with motility, as opposed to conventional pharmaceutical treatments that focus on specific pathways[19-21]. In the complicated context of FGID, where symptoms frequently result from the interaction of several causes, this multitarget strategy is very helpful. Herbal remedies provide a thorough and flexible therapeutic alternative until customised therapies with customised bioactive blends are generally accessible[22,23].

3.1 Fennel

Fennel (*Foeniculum vulgare*) is a popular aromatic herb used as a spice and medicinal remedy. It is well-known for its carminative, expectorant, and diuretic qualities, which aid in the removal of mucus, fluid retention, and dyspeptic conditions, including indigestion and bloating. Numerous phytochemicals (Table 1), such as flavonoids, phenolic compounds, and essential oils like fenchone and anethole, are abundant in it[24]. About 77% of moms in a study evaluating the use of medicinal plants in Turkey reported using tea made with fennel to relieve their kids' constipation and flatulence[25]. Extract of fennel seeds has shown medicinal properties. and preventive benefits in a mouse colitis produced by Dextran Sulfate Sodium (DSS). Both histologically and macroscopically, it considerably reduced colitis symptoms and structural damage. Fennel seed extract prevented the loss of Transepithelial Electrical Resistance (TEER), a sign of enhanced epithelial barrier function, and decreased the ulcer index in the midcolon. These results demonstrate that fennel seed extract might prove to be an excellent remedy for inflammatory bowel illness. Additionally, it was demonstrated that fennel seed extract had an anti-inflammatory impact linked to decreased STAT pathway activation in intestinal epithelial cells and animals with DSS-induced colitis[26].

3.2 Cumin

In Indian Ayurvedic medicine, cumin seeds (*Cuminum cyminum L.*) are highly valued for their medicinal properties, particularly in treating indigestion, chronic diarrhoea, and dyspepsia. They are traditionally utilised for managing several conditions, like acute gastritis, diabetes, as well as cancer, demonstrating their broad therapeutic potential in addition to their culinary application as aromatic spices[27]. Cuminaldehyde, thymol, terpinene, oleoresin and other significant constituents that exist in cumin have been linked to their effectiveness in treating a variety of illnesses. Two of the main bioactive substances in cumin, cuminaldehyde and thymoquinone (Table 1), have potential medical uses[28]. In rats, a dietary pectic polysaccharide derived from Black Cumin Seeds (BCPP) aids in the healing of stomach ulcers. By enhancing the stomach's protective mucus and important repair-promoting chemicals like COX-2 and PGE2, BCPP, when administered for 10 days, enhanced ulcer healing. Additionally, it inhibited damaging acid activity, decreased damage from free radicals, and balanced the enzymes MMP-2 and MMP-9[29]. By lowering Malondialdehyde (MDA) and raising reduced Glutathione (GSH) levels, cumin essential oil has been demonstrated in another study to control oxidative stress indicators and promote tissue healing. It also promotes the synthesis of Prostaglandin E2 (PGE2), which aids in the healing and protection

of the mucosa. Inhibiting inflammatory enzymes like cyclooxygenase-2 (COX-2) is one of its anti-inflammatory properties, which lowers inflammation and encourages the regeneration of the stomach mucosa[30].

3.3 Ginger

A common spice is ginger, also called *Zingiber officinale*. Gingerol, shogaol, and zingerone are some of the active ingredients that give ginger its medicinal properties (Table 1). The suppression of intestinal M3 and 5-HT3 receptors is part of ginger's Mode of Action (MoA). This improves stomach motility, reduces transit time, and lessens nausea and vomiting. It works especially well for gastrointestinal conditions where these symptoms are common[31-33]. In progressed patients with cancer (n = 14) with loss of appetite and weight loss condition, a study discovered that ginger (One thousand six hundred fifty milligram daily) effectively reduced upper digestive tract symptoms like nausea, anorexia, and heartburn, ulcer indications, and dysmotility[34]. Some studies highlight the potential benefits of ginger in managing bowel disorders. In individuals with IBS and Inflammatory Bowel Disease (IBD), a daily dosage of 2000mg has demonstrated effectiveness in lowering inflammation, easing dyspepsia, and treating colorectal cancer and digestive tract ulcers[35-37].

3.4 *Aloe Vera*

Aloe vera, a succulent, tolerant of dry conditions, perennial plant in the family Asphodelaceae, is utilised in traditional Chinese medicine (*luhui*) and Indian medicine (*Ghrita kumari*). Of the 420 Aloe species, *A. vera* (AV) is one of the most potent bioactive plants. It contains over 200 bioactive chemicals (Table 1) and 75 nutrients[38]. The data also suggests several medicinal advantages, including an inflammation reducer, analgesic, anti-oxidant, antiproliferative, and anti-diabetic properties[39]. Important aloe vera components, including aloin B, aloenin, aloe-emodin, aloesin and aloin A, were found to have potential anti-constipation properties in a study. Aloin A and B, Aloe-emodin and Aloeresin D, were the ones that showed the best pharmacokinetic profiles, with slower elimination rates and improved absorption[40]. According to a different study, Aloe Polysaccharides (APs) enhanced gut health by boosting the production of Short Chain Fatty Acids (SCFA) and modifying microbiota. APs decreased Firmicutes and Clostridium while increasing bacteria that produce SCFA, such as Bacteroides and Parabacteria. Additionally, they demonstrated their prebiotic potential by upregulating important enzymes to improve the metabolism of fructose and mannose[41]. Studies on the usefulness of AV gel in the management of GERD are compiled in a current review. It includes five clinical investigations comparing the effects of ten millilitres of AV gel syrup twice daily vs omeprazole, pantoprazole, and ranitidine in GERD patients. Compared to omeprazole or ranitidine[42], it was discovered that AV gel syrup greatly reduced GERD indications while avoiding negative side effects. According to the study, eating aloe vera (AV) helped adults with IBD achieve better health outcomes and showed promise in treating GERD, IBD, and stomach ulcers[43-45]. In a DSS-induced colitis animal model, AV-derived nanovesicles were found to be a promising therapy for IBD by reducing inflammation and improving tight junction proteins[46]. Additionally, glucomannan from AV gel polysaccharide protected against DSS-induced colitis, highlighting its therapeutic benefits in gut health[47].

3.5 Chia

Chia is a herbaceous plant that is part of the Lamiaceae family and is referred to scientifically as *Salvia hispanica*. Many health advantages, including better blood lipid profiles, hypotension, hypoglycemia, antioxidant, antibacterial, and immunostimulatory actions, have been demonstrated for chia seeds[48-51]. According to a study, glucoxylan, protein from peas, and powder of chia seeds together were safe and therapeutically beneficial for those with IBS-C. It increased the quality of life for patients, decreased the severity of symptoms, and improved stool consistency. Changes in serum zonulin levels also suggested that the therapy would help restore intestinal permeability[52]. According to a different study, the mucilage of *Salvia hispanica* considerably reduces the symptoms of IBS in animal models.

At a dose of 100 mg/kg, it improves faecal frequency, enhances serotonin levels, and shows anti-constipation effects. It also demonstrates effectiveness in reducing haemorrhoid severity and improving gut motility, proving its therapeutic potential in managing IBS[53].

Table 1. Overview of herbal drugs, their bioactive components, and associated bioactivities

S.No.	Herbal Drug	Bioactives	Bioactivities	References
1.	Fennel	Anethole, Fenchone	Antioxidant, antimicrobial, antispasmodic, gastroprotective and anti-inflammatory	66,67
2.	Cumin	Cuminaldehyde, Thymoquinone	Antioxidant, anti-inflammatory, gastroprotective, anticancer, immunomodulatory and cardioprotective	68
3.	Ginger	Gingerols, zingerone	Antioxidant, antimicrobial, anti-diabetic, neuro-protective, analgesic, cardio protective, gastro protective, anti-inflammatory and anticancer	69,70
4.	Aloe vera	Anthraquinones, Anthrones	Antioxidant, antimicrobial, anti-diabetic, gastroprotective, anti-inflammatory and anticancer.	71
5.	Cinnamon	Catechin and Cinnamic acid	Antioxidant, antimicrobial, anti-diabetic, cardio-protective, gastro-protective, anti-inflammatory and anticancer.	72
6.	Licorice	Glycyrrhizin	Antimicrobial, cardio-protective, gastro-protective, hepatoprotective, anti-inflammatory and anticancer.	73

3.6 Cinnamon

The primary ingredients of cinnamon (*Cinnamomum zeylanicum*), a spice, are cinnamon bark and leaves. Its phytochemically rich profile, which includes anti-inflammatory, anti-cancer, antihyperglycemic, antimicrobial, and antioxidant qualities, has earned it recognition (Table 1). It has demonstrated efficacy as an at-home treatment for IBS, specifically IBS with diarrhoea, by controlling stomach dysmotility and lowering abdominal pain[54]. Additionally, in China, cinnamon is an essential part of formulations used in traditional Chinese medicine to treat IBS-D[55]. Cinnamon Extract (CE) reduced symptoms like visceral hyperalgesia and frequency of bowel movements for rats with irritable bowel syndrome with diarrhoea (IBS-D). CE showed effectiveness similar to that of the serotonin receptor antagonist Ramosetron by reducing high 5-HT levels and the expressed Tryptophan 5-monooxygenase 1, which controls the synthesis of 5-HT.

Important elements of CE, including cinnamic acid and catechin, directly reduced Tph1 activity, suggesting that it may be used as a natural remedy for IBS-D[56]. In a different study, an 8-week trial revealed that cinnamon water extract reduced the symptoms of diarrhoea. Those who took cinnamon extract capsules had lower amounts of agmatine and indole in their faeces and higher levels of spermidine, faecal isobutanoic acid, and colonic time to transit. Analysis of the gut microbiota showed improved diversity and advantageous alterations, such as a favourable relationship between stool phenol levels and Bifidobacterium longum. According to the research, cinnamon extract reduces diarrhoea via altering metabolism and microbes[57].

3.7 Liquorice

The liquorice plant, *Glycyrrhiza glabra*, which is found in Asia, Southern Europe, and the Middle East, is the source of liquorice root. Although liquorice root has around 300 different components, glycyrrhizin is the main active ingredient. This is what gives the root its sweet flavour and its antibacterial, anti-inflammatory, and antioxidant qualities[58]. According to research on animals, its anti-ulcer properties are associated with enhanced mucus formation, suppression of prostaglandin synthesis, and free radical scavenging[59-62]. Glycyrrhizin and licoflavone are the main active components in charge of these effects[63,64].

A study evaluated the effect of a combination of yarrow, liquorice, and chamomile on symptoms of irritable bowel syndrome. In a double-blinded clinical trial with 102 patients, the herbal cocktail significantly improved symptoms such as abdominal pain, bloating, constipation, diarrhoea, and mucus excretion over 2 to 4 weeks. The findings (Table 1) highlight the potential of this inexpensive and safe plant-based treatment for managing IBS symptoms effectively[65].

4. Discussion

The review highlights the multifactorial nature of FGID, emphasising the critical roles played by visceral hypersensitivity, gut-brain axis dysregulation, altered gut microbiota, low-grade inflammation, and psychosocial factors in their pathophysiology. The interplay between these mechanisms, particularly through neural and immune pathways, underlines the complexity of

diagnosis and treatment. This complexity often renders conventional pharmacological interventions insufficient, driving the exploration of alternative therapeutic options such as herbal remedies[74].

Herbal medicines offer a unique advantage by targeting multiple pathogenic pathways simultaneously. The reviewed botanicals, including fennel, cumin, ginger, aloe vera, chia, cinnamon, and liquorice, exhibit diverse pharmacological properties like anti-inflammatory, antioxidant, mucosal protective, and microbiota-modulating effects. Their mechanisms of action align closely with the key pathophysiological targets in FGID. For instance, fennel and cumin have demonstrated significant anti-inflammatory effects and mucosal protection, making them viable in managing conditions like IBS and colitis[75]. Ginger's inhibition of cholinergic and serotonergic receptors aligns well with its antiemetic and motility-regulating effects, supporting its use in functional dyspepsia and IBS[76]. Similarly, aloe vera's efficacy in GERD and IBD stems from its prebiotic action and tight junction modulation[77]. Additionally, many of these herbal remedies modulate key molecular signalling pathways such as the COX-2/PGE2 axis, STAT signalling, and serotonin synthesis, indicating that their effects are not merely symptomatic but may offer disease-modifying potential. Several agents also showed promise in modulating the microbiome composition, a crucial aspect in the gut-brain axis and immune homeostasis.

5. Conclusion

Functional gastrointestinal disorders represent a significant healthcare challenge due to their multifaceted aetiology and persistent symptoms. Herbal medicines, with their multitargeted mechanisms and favourable safety profiles, offer a compelling adjunct or alternative to conventional therapies. The reviewed herbs—fennel, cumin, ginger, aloe vera, chia, cinnamon, and liquorice—demonstrated beneficial effects across multiple FGID subtypes, acting through modulation of inflammation, gut microbiota, mucosal healing, and neural signalling.

Future research needs to prioritise mechanistic studies, clinical validations, and personalised treatment frameworks to optimise the integration of herbal therapies into FGID management. Embracing a holistic and evidence-based approach that bridges traditional knowledge with modern science could pave the way for more effective and patient-centred solutions in managing these chronic gastrointestinal disorders.

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7. Author Contribution

Writing—original draft preparation, writing—review and editing, A.S.; conceptualisation and validation, S.D.; supervision, A.M.

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