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Review Article

Gastroprotective Activity of Floating Antacid Tablet Containing Ginger and Liquorice

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ABSTRACT

Gastric irritation and ulcerative injury arise when damaging influences such as hydrochloric acid, pepsin, non-steroidal anti-inflammatory drugs, alcohol, infection, oxidative stress and inflammation overcome the protective capacity of the gastric mucosa. Conventional immediate-release oral dosage forms may have a short gastric residence time and may not maintain prolonged local contact with the stomach. This review examines the scientific rationale for investigating a floating antacid tablet containing Ginger (Zingiber officinale Roscoe) and Liquorice (Glycyrrhiza glabra L.). Ginger contains phenolic constituents, particularly gingerols and shogaols, that have been associated in preclinical and broader pharmacological literature with antioxidant and anti-inflammatory effects. Experimental evidence also indicates that selected ginger preparations can reduce ethanol/acid-induced gastric mucosal injury in animals, although this does not establish clinical efficacy of a proposed tablet.[1–4] Liquorice contains glycyrrhizin, glycyrrhetinic acid, flavonoids and other constituents linked with mucosal, antioxidant and anti-inflammatory effects; recent reviews and experimental studies support continued investigation while emphasizing dose and safety constraints.[5–8] An antacid component could provide direct acid neutralization, whereas an effervescent or non-effervescent floating matrix could prolong gastric residence and regulate release. The combined system therefore represents a plausible formulation hypothesis rather than proof of synergism or therapeutic effectiveness. Important development requirements include botanical authentication, standardized extracts, compatibility testing, acid-neutralizing capacity, buoyancy, dissolution, stability, pharmacological validation and, ultimately, appropriately designed clinical

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studies. The concept may be significant as an integrated local gastric delivery platform, but its performance and safety must be demonstrated experimentally.

INTRODUCTION

Gastrointestinal disorders include dyspepsia, gastritis, gastro-oesophageal reflux, gastric erosions and peptic ulcer disease. Gastric mucosal injury is not determined by acid alone; it reflects an imbalance between luminal aggressors and mucosal defense, repair and adaptation. Acid and pepsin, Helicobacter pylori infection, non-steroidal anti-inflammatory drugs, alcohol, smoking, ischemia, stress and inflammatory or oxidative processes may contribute to damage. Contemporary reviews describe gastric mucosal protection as a coordinated system involving mucus and bicarbonate, epithelial integrity, blood flow, prostaglandins, immune regulation and repair.[9,10]

The therapeutic objective is therefore broader than simply suppressing acid. Acid neutralization may rapidly reduce luminal acidity, while cytoprotective, antioxidant and anti-inflammatory approaches may support the mucosal environment. Antacids are useful for symptom relief and direct neutralization, but their action may be relatively short and conventional tablets can leave the stomach rapidly. The clinical significance of any herbal component also depends on botanical identity, extraction, dose, chemical composition and evidence quality.

Gastroretentive drug-delivery systems are designed to prolong residence in the stomach. Floating systems use a dosage form whose apparent density remains lower than gastric fluid, allowing it to remain buoyant while releasing the incorporated materials. Reviews emphasize that gastric retention is influenced by fed or fasted state, motility, dosage-form size and density, polymer hydration, fluid availability and individual physiology.[11–16] A floating antacid tablet containing Ginger and Liquorice could consequently be investigated as a local, prolonged-contact platform. This is a formulation rationale, not evidence that the specific combination has established clinical efficacy.

2. Gastroprotective Activity

2.1 Definition of gastroprotection

Gastroprotection refers to preservation or restoration of gastric mucosal integrity against chemical, mechanical, infectious, inflammatory and oxidative injury. It may involve reduction of acid-peptic aggression, enhancement of mucus or bicarbonate, maintenance of mucosal blood flow, antioxidant defense, modulation of inflammation, epithelial restitution and ulcer healing. The term should not be used to imply clinical prevention unless supported by appropriate clinical evidence.

2.2 Gastric mucosal defense mechanisms

The pre-epithelial mucus–bicarbonate layer creates a pH gradient and limits diffusion of acid and pepsin. Surface epithelial cells form a selectively permeable barrier through tight junctions and rapidly replace damaged cells. Adequate mucosal blood flow supplies oxygen and nutrients, removes acid equivalents and supports repair. Prostaglandins contribute to mucus and bicarbonate secretion, blood flow and epithelial restitution. Neural, immune and growth-factor pathways further coordinate adaptation and healing.[9,10]

2.3 Factors responsible for gastric mucosal damage

Important damaging factors include excessive or prolonged acid-peptic exposure, H. pylori-associated inflammation, NSAID-related impairment of prostaglandin-dependent defenses, alcohol, smoking, bile reflux, ischemia, severe physiological stress and dietary or chemical irritants. Gastric injury is multifactorial; therefore, a formulation that only neutralizes acid may not address all mechanisms.

2.4 Role of acid, pepsin, oxidative stress and inflammation

Hydrochloric acid can injure epithelium when defensive barriers are impaired, while pepsin degrades proteins within damaged tissue and mucus. Reactive oxygen species can cause lipid, protein and DNA injury and can amplify inflammatory signaling. Inflammation may involve cytokines, neutrophil recruitment, myeloperoxidase activity and nuclear factor-κB-related

pathways. These mechanisms are interconnected rather than independent.

2.5 Mechanisms involved in gastroprotection

Possible mechanisms include acid neutralization or suppression, enhancement of mucus and bicarbonate, increased prostaglandin-associated defense, improved blood flow, antioxidant activity, down-regulation of inflammatory mediators, inhibition of damaging microbial adhesion or growth, and stimulation of epithelial repair. Different botanical preparations may act through different combinations of these pathways.

2.6 Pharmacological approaches for gastric protection

Current approaches include antacids, alginates, H2-receptor antagonists, proton-pump inhibitors, mucosal protective agents and eradication therapy when H. pylori is present. Herbal preparations may be studied as adjunctive or supportive products, but they should not replace diagnosis or evidence-based treatment of alarm symptoms, bleeding, perforation or confirmed infection.

3. Ginger (Zingiber officinale Roscoe)

3.1 Botanical profile, biological source and family

Ginger is a perennial herb whose medicinally used portion is the rhizome. The accepted botanical name is Zingiber officinale Roscoe, and it belongs to the family Zingiberaceae. Fresh and dried rhizomes differ in composition because processing can convert gingerols into shogaols and related products.[1,2,17]

3.2 Major phytoconstituents

Ginger contains pungent phenolics such as 6-gingerol and other gingerols, shogaols, paradols, zingerone and gingerdiols. Volatile oil components include sesquiterpenes and monoterpenes. Polysaccharides, flavonoids and other phenolic compounds may also contribute to biological activity. Composition varies with cultivar, geography, maturity, drying and extraction method.[1,2,17–19]

3.3 Gingerol, shogaol and related constituents

Gingerols are prominent constituents of fresh ginger, whereas dehydration and heat can promote formation of shogaols. Shogaols and paradols may possess different physicochemical and biological properties from gingerols. For a pharmaceutical formulation, the extract type and processing conditions should be defined because total plant powder and standardized extract cannot be assumed to be equivalent.

3.4 Pharmacological activities

Literature describes antioxidant, anti-inflammatory, antiemetic, analgesic, antimicrobial and gastrointestinal effects of ginger. Human evidence is strongest for selected indications such as nausea, while evidence for gastric ulcer prevention or treatment is less mature and is often preclinical or preparation-specific.[2,3,18,19]

3.5 Antioxidant and anti-inflammatory properties

Ginger constituents have been associated with modulation of inflammatory mediators and oxidative-stress markers. A systematic review of randomized trials evaluated anti-inflammatory effects, while broader reviews describe pathways involving NF-κB, cyclooxygenase/lipoxygenase-related mediators and antioxidant defenses.[3,18,19] These findings support a possible gastroprotective rationale but do not prove local gastric action from a floating tablet.

3.6 Evidence related to gastroprotective/anti-ulcer activity

In a 2020 rat study, steamed ginger extract reduced ethanol/hydrochloric-acid-induced gastric mucosal injury and was associated with changes in antioxidant and inflammatory parameters, including glutathione-related defenses, catalase, superoxide dismutase, lipid peroxidation, myeloperoxidase and inflammatory signaling.[4] This is relevant preclinical evidence for a ginger preparation, but the dose, extract and animal model cannot be directly extrapolated to humans or to the proposed combination tablet.

3.7 Possible mechanism of gastroprotection

A possible model is that ginger phenolics reduce oxidative injury and inflammatory signaling, while the rhizome matrix or associated constituents may support mucosal tolerance. The evidence does not establish a single mechanism, a clinically effective dose, or a confirmed interaction with an antacid.

3.8 Safety and limitations

Ginger is widely consumed and is generally tolerated at customary dietary doses. Reported concerns include gastrointestinal discomfort, product variability and possible interactions, particularly where bleeding risk or concomitant medicines are relevant. Clinical trials have used heterogeneous preparations and doses; therefore, safety data for a concentrated extract in a gastroretentive tablet would need to be generated separately.[3,18,19]

Table 1: Major Phytoconstituents of Ginger and Their Reported or Proposed Activities.[1–4,17–19]

Constituent/group	Reported or proposed activity	Interpretive caution
Gingerols	Antioxidant and anti-inflammatory activity; pungency	Content changes with processing and extraction.
Shogaols	Phenolic bioactivity and possible anti-inflammatory effects	May increase during drying or heating; not equivalent to fresh ginger.
Paradols and zingerone	Antioxidant and gastrointestinal-related activity reported in experimental literature	Evidence is constituent- and model-dependent.
Volatile oils	Aromatic and pharmacological contributions	Volatility and storage stability require control.
Polysaccharides/other phenolics	Possible antioxidant or biological contribution	Complex, variable fraction; requires characterization.

4. Liquorice (Glycyrrhiza glabra L.)

4.1 Botanical profile, biological source and family

Liquorice is obtained principally from the roots and stolons of Glycyrrhiza glabra L., a perennial leguminous plant in the family Fabaceae. The identity of the species and plant part is important because Glycyrrhiza species and commercial materials may differ in constituent profile.[5,6,20]

4.2 Major phytoconstituents

Liquorice contains triterpenoid saponins, especially glycyrrhizin or glycyrrhizic acid, which can be metabolized to glycyrrhetinic acid. Flavonoids include liquiritin, liquiritigenin, isoliquiritigenin and glabridin, while chalcones, coumarins, polysaccharides and other phenolics may also be present.[5–7,20,21]

4.3 Glycyrrhizin/glycyrrhizic acid and flavonoids

Glycyrrhizin is a major saponin associated with both pharmacological activity and safety concerns. Flavonoids may contribute antioxidant, anti-inflammatory and barrier-related effects. Because glycyrrhizin content varies and is not uniformly removed in commercial extracts, the amount of glycyrrhizin should be quantified and controlled during formulation.

4.4 Pharmacological activities

Reviews describe anti-inflammatory, antioxidant, antimicrobial, immunomodulatory, hepatoprotective and mucosal effects of Liquorice. The breadth of activity should not be interpreted as proof of effectiveness for every indication or dosage form.[5–8,20,21]

4.5 Gastroprotective and anti-ulcer evidence

Glycyrrhiza-derived materials have a long history of use in gastric complaints. Recent experimental work reported anti-gastric-ulcer effects from carbon dots derived from Glycyrrhizae Radix et Rhizoma in an alcohol-related mouse model, with changes in oxidative-stress-associated measures.[8] A 2021 study of glycyrrhizic-acid-loaded polymeric nanoparticles also reported mucoprotective effects in a chemotherapy-induced intestinal mucositis model.[22] These studies support investigation of Liquorice-derived materials but are not direct evidence for a Ginger–Liquorice floating antacid tablet.

4.6 Possible mechanisms

Possible mechanisms include reinforcement of mucus-related defenses, antioxidant activity, modulation of inflammatory pathways, support of epithelial repair and, depending on preparation, interference with microbial adhesion. Mechanistic findings differ among

extracts, isolated compounds and delivery systems; they should therefore be described as possible mechanisms unless directly demonstrated in the final product.

4.7 Antioxidant/anti-inflammatory contribution

Liquorice flavonoids and saponin-related constituents may reduce oxidative and inflammatory processes in experimental settings. These properties could complement direct acid neutralization, but the relative contribution of each constituent and the amount delivered to gastric tissue remain uncertain.

4.8 Safety considerations and limitations

Excessive or prolonged exposure to glycyrrhizin can produce pseudoaldosteronism-like effects, including sodium and water retention, hypokalaemia and elevated blood pressure; susceptibility is greater in people with hypertension, renal, hepatic or cardiovascular disease. The European Medicines Agency advises restrictions and cautions for susceptible groups and insufficiently studied populations.[23] Accordingly, a Liquorice-containing formulation requires dose justification, glycyrrhizin control, duration limits and appropriate labeling.

Table 2: Major Phytoconstituents of Liquorice and Their Reported or Proposed Activities.[5–8,20–23]

Constituent/group	Reported or proposed activity	Safety/formulation relevance
Glycyrrhizin/glycyrrhizic acid	Mucosal, anti-inflammatory and antioxidant-related effects reported	Must be quantified because chronic/excessive intake can cause mineralocorticoid-related adverse effects.
Glycyrrhetinic acid	Metabolite linked to pharmacological activity	Systemic exposure and metabolism influence safety.
Liquiritin/liquiritigenin	Flavonoid antioxidant and anti-inflammatory activity	Content varies with species and extraction.
Isoliquiritigenin/glabridin	Flavonoid/chalcone biological activity	Evidence is often experimental and not formulation-specific.
Polysaccharides and phenolics	Possible mucosal or antioxidant contribution	Complex fractions require identity and batch control.

5. Rationale for Combining Ginger and Liquorice

The proposed combination is based on complementary rather than identical pharmacological hypotheses. Ginger provides phenolic constituents associated with antioxidant and anti-inflammatory effects, while Liquorice provides saponins, flavonoids and other constituents associated with mucosal, antioxidant and inflammatory modulation. An antacid would act by a distinct physicochemical mechanism: neutralization of luminal acid.

The combination may therefore be investigated for multi-component coverage of acid-peptic aggression, oxidative stress, inflammation and mucosal defense. A floating matrix could maintain the materials in the gastric region for longer than an immediate-release tablet. However, “complementary mechanisms” is a research rationale; it does not establish pharmacological synergy. Synergy would require appropriate combination studies, dose–response analysis and interaction modeling in validated experimental systems.

6. Antacid Therapy

6.1 Definition and mechanism

Antacids are basic substances that react chemically with gastric hydrochloric acid and raise gastric pH. Depending on the ingredient, neutralization may produce water, salts and, for carbonate or bicarbonate systems, carbon dioxide. The immediate effect is reduction of free acidity; antacids do not eradicate H. pylori and do not replace definitive treatment of ulcer complications.

6.2 Common antacid ingredients

Common ingredients include aluminium hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, sodium bicarbonate and combinations of aluminium and magnesium salts. Ingredient selection affects neutralization capacity, onset, duration, sodium load, bowel effects and interaction potential.

6.3 Acid neutralization

Acid-neutralizing capacity (ANC) is commonly expressed as milliequivalents of hydrochloric acid neutralized under a defined test procedure. A 2022 evaluation used the United States Pharmacopeia procedure to compare marketed antacids and reported that tested products met the minimum requirement used in that context, while performance differed with composition and dosage form.[24] The United States FDA OTC monograph also specifies acid-neutralizing-capacity requirements for covered antacid products. [25]

6.4 Advantages and limitations

Antacids can act rapidly and are suitable for episodic symptoms. Limitations include short duration, variable performance with food and gastric contents, constipation or diarrhoea depending on the salt, electrolyte or sodium concerns, and binding or altered absorption of other medicines. An antacid-containing floating tablet must therefore be assessed for both pharmacotechnical performance and drug–nutrient or drug–drug interactions.

6.5 Rationale for incorporation into a gastroretentive formulation

Incorporating an antacid into a floating system could prolong contact of the neutralizing material with gastric fluid and allow controlled liberation rather than a single immediate bolus. It could also generate carbon dioxide in an effervescent design. However, gas generation must be balanced against tablet integrity, local pH, extract stability and the intended release profile.

7. Floating Drug Delivery System

7.1 Definition and principle of gastroretention

A floating drug-delivery system is a low-density gastroretentive dosage form designed to remain buoyant on gastric contents. Gastroretention is useful when prolonged gastric exposure, local gastric action, controlled release or delivery to the upper gastrointestinal tract is desired. It is not a guarantee of fixed residence time because gastric emptying remains physiologically variable.[11–16]

7.2 Gastric physiology and residence time

Gastric motility differs between fasting and fed states and is influenced by meal composition, posture, disease, age and individual variability. The migrating motor complex can propel indigestible material toward the pylorus during fasting. A floating dosage form may remain in the stomach only while sufficient fluid, buoyancy and favorable motility conditions exist.

7.3 Types of floating systems

Effervescent systems contain a gas-generating couple, usually an acid and carbonate or bicarbonate, that produces carbon dioxide after hydration. Non-effervescent systems rely on swellable hydrophilic polymers, hollow structures, low-density excipients or gel-forming matrices to maintain density below gastric fluid. Related gastroretentive categories include raft-forming, mucoadhesive, expandable, high-density, magnetic and superporous systems.[11–16]

7.4 Mechanism of buoyancy

After contact with gastric fluid, an effervescent tablet hydrates and generates gas. Polymer swelling and a hydrated gel layer entrap the gas, reduce apparent density and regulate diffusion. In non-effervescent systems, polymer hydration and structural porosity provide buoyancy without a gas-generating reaction. Floating lag time and total floating time depend on formulation composition and test conditions.

7.5 Advantages, limitations and applications

Potential advantages include prolonged gastric contact, controlled release, reduced dosing frequency, local delivery and improved exposure for suitable drug

candidates. Limitations include dependence on gastric fluid and motility, risk of premature emptying, dose-loading constraints, variability between patients and difficulty translating in-vitro buoyancy to in-vivo retention. Applications include local gastric therapy, delivery of drugs with upper-GI absorption windows and prolonged release of selected orally administered agents.[11–16]

7.6 Factors affecting gastric retention

Important variables include tablet density and size, swelling capacity, polymer viscosity, gas generation, tablet strength, fed or fasted state, meal composition, posture, gastric emptying, disease state and concomitant medicines. The formulation should be designed and tested under physiologically relevant conditions rather than relying on a single buoyancy experiment.

Table 3: Types of Gastroretentive Drug-Delivery Systems and Their Design Features.[11–16]

System	Retention mechanism	Typical formulation concept	Main limitation
Effervescent floating	CO_2 generation trapped in hydrated matrix	Acid–bicarbonate/carbonate pair with HPMC or similar polymer	Gas loss, pH sensitivity and possible structural failure.
Non-effervescent floating	Swelling, gel formation, hollow or low-density structure	Hydrophilic polymers, porous excipients or lipidic structure	May require long hydration time and adequate gastric fluid.
Raft-forming	Viscoelastic barrier or raft at gastric surface	Alginate/pectin with carbonate or bicarbonate	Sensitive to composition and gastric conditions.
Floating–mucoadhesive	Buoyancy plus adhesion to mucosa	Polymer blend containing bioadhesive component	Mucosal adhesion is variable and may cause irritation.
Expandable/swellable	Increase in size after administration	Swelling polymers or unfolding devices	Safety, pyloric passage and retrieval require consideration.

8. Floating Antacid Tablet Containing Ginger and Liquorice

The proposed tablet is a conceptual multi-component gastroretentive dosage form. The antacid would provide direct neutralization; Ginger would contribute a standardized rhizome extract or powder selected for phenolic content and gastrointestinal relevance; Liquorice would contribute a controlled root extract with quantified glycyrrhizin; and the floating matrix would prolong gastric residence and modulate release. No specific composition, dose, floating time or release result should be claimed without experimental validation.

8.1 Possible excipients and their functions

A formulation may include sodium bicarbonate with citric or tartaric acid for effervescence, or may use a non-effervescent polymeric matrix. HPMC, polyethylene oxide, sodium alginate, xanthan gum or similar hydrophilic polymers can provide swelling and gel formation. Microcrystalline cellulose, lactose or mannitol may serve as diluents; povidone or pregelatinized starch as binders; magnesium stearate or sodium stearyl fumarate as lubricants; and colloidal silicon dioxide as a glidant. Sweeteners or flavors may be considered only after assessing compatibility, moisture sensitivity and the intended product profile.[13–16,26]

Table 4: Common Excipients That May Be Considered for a Floating Tablet; These Are Proposed Options, Not a Validated Formula.[13–16,26]

Excipient class	Examples	Proposed function	Key caution
Gas-generating agents	Sodium bicarbonate; calcium carbonate	Generate CO_2 and support buoyancy	Control moisture and acid/base ratio.
Acidulants	Citric acid; tartaric acid	React with bicarbonate/carbonate	May alter extract stability and local pH.

Excipient class	Examples	Proposed function	Key caution
Hydrophilic polymers	HPMC; polyethylene oxide; sodium alginate; xanthan gum	Swelling, gel formation and release control	Viscosity and concentration affect lag time and release.
Binders	Povidone; pregelatinized starch	Granule or tablet strength	Excess can slow disintegration or release.
Fillers/diluents	Microcrystalline cellulose; lactose; mannitol	Bulk and compressibility	Sugar alcohols and sugars may affect hygroscopicity.
Lubricants/glidants	Magnesium stearate; sodium stearyl fumarate; colloidal silicon dioxide	Reduce friction and improve flow	Over-lubrication can impair wetting and release.
Palatability agents	Permitted sweetener/flavor	Acceptability	Must be compatible with botanicals and antacid.

9. Formulation Approaches

9.1 Direct compression

Direct compression is simple and avoids water or heat, which may benefit moisture- or heat-sensitive phytoconstituents. It requires powders with suitable flow, compressibility and content uniformity. Herbal powders can be challenging because of irregular particle size, low density and variable moisture; co-processing or dry granulation may be necessary.

9.2 Wet granulation

Wet granulation can improve flow and compressibility and may reduce segregation of antacid and botanical powders. It can, however, expose Ginger constituents, Liquorice constituents and effervescent components to water or drying heat. An aqueous granulation process would generally be inappropriate for a moisture-sensitive acid–bicarbonate system unless components are protected or added after drying.

9.3 Effervescent floating approach

An effervescent design would use bicarbonate or carbonate with an acidulant. Hydration initiates carbon dioxide generation, while a polymeric gel traps gas. The acid–base ratio, compression force, moisture content, polymer viscosity and tablet porosity require optimization. Excessive gas evolution can cause rapid erosion or fragmentation, whereas insufficient gas can prevent buoyancy.

9.4 Non-effervescent floating approach

A non-effervescent matrix can rely on swelling and low-density excipients. This approach avoids acid–base reactions but may show a longer floating lag time. Polymer selection should provide adequate hydration, matrix integrity and release control without producing an overly large or hard-to-empty mass.

9.5 Polymer selection and optimization

Optimization should consider drug/extract loading, polymer type and concentration, gas-generating level, compression force, tablet dimensions, hardness, lag time, total floating time, swelling and release. Factorial or response-surface designs can evaluate interactions rather than changing one variable at a time. Modern literature also describes advanced manufacturing and 3D-printed floating systems, but these approaches are exploratory for the present herbal-antacid concept.[14–16,27–29]

9.6 Compatibility studies

Compatibility should be examined between Ginger extract, Liquorice extract, antacid, acidulant, polymer and lubricant. Fourier-transform infrared spectroscopy, differential scanning calorimetry, powder X-ray diffraction, thermogravimetric analysis, microscopy and chromatographic profiling may be used as appropriate. Any evidence of chemical degradation, unexpected acid–base reaction, moisture uptake or altered flow should be addressed before compression.

10. Evaluation of Floating Tablets

Evaluation should combine pharmacopoeial tablet tests with gastroretentive and antacid-specific tests. The purpose is not merely to demonstrate that a tablet floats, but to establish reproducible manufacture, mechanical

integrity, controlled release and acid-neutralizing performance.

Table 5: Evaluation Parameters for a Proposed Floating Antacid Tablet Containing Ginger and Liquorice.[13–16,24–29]

Parameter	Purpose and interpretation
General appearance	Assesses color, odor, shape, surface defects, capping and visible uniformity.
Weight variation	Indicates consistency of tablet mass and manufacturing control.
Thickness and diameter	Monitor dimensional uniformity and compression behavior.
Hardness	Measures resistance to handling; excessive hardness may delay hydration and release.
Friability	Assesses tendency to lose mass during handling and transport.
Drug/content uniformity	Required where active extract or quantified constituent is used; verifies dose consistency.
Floating lag time	Time required to rise and remain buoyant after immersion; shorter is not always better if integrity is compromised.
Total floating time	Duration of buoyancy under defined medium, agitation and temperature.
Swelling index	Tracks hydration and dimensional change, which influence buoyancy and release.
In-vitro buoyancy	Measures proportion of floating units and may include floating-force or gravimetric testing.
Acid-neutralizing capacity	Quantifies hydrochloric acid neutralized by the antacid-containing tablet using a validated titrimetric or pharmacopoeial procedure.
Dissolution/drug release	Determines release of antacid-related or quantified botanical constituents in simulated gastric medium.
Kinetic models	Zero-order, first-order, Higuchi and Korsmeyer–Peppas models may help describe release; model selection must be based on fit and mechanism, not only correlation.
Stability studies	Assess potency, glycyrrhizin and ginger constituent profile, moisture, hardness, buoyancy, ANC and release under ICH-relevant conditions.

10.1 In-vitro acid-neutralizing capacity

For this concept, ANC should be tested in a defined volume of hydrochloric acid under controlled temperature and agitation. The endpoint, sample quantity, contact time and titration procedure should be specified and validated. Because a floating matrix releases material over time, both total ANC and time-dependent neutralization may be informative. In-vitro results should not be presented as direct clinical evidence.

10.2 Drug release and phytochemical quantification

A formulation study should select suitable quantitative assays for the standardized extracts or representative controlled constituents. The assay must be validated for specificity, accuracy, precision, linearity and stability-indicating capability. In the present review, no constituent is designated as an “analytical marker”; instead, the paper refers to quantified constituents or quality-control analytes.

10.3 Stability

Stability assessment should include appearance, mass, mechanical properties, moisture, extract potency, glycyrrhizin content, selected ginger constituents, ANC, floating behavior and dissolution. Effervescent systems are particularly vulnerable to moisture, while volatile ginger components may require protective packaging.

11. Mechanism of Action – Conceptual Model

The following is a proposed or possible mechanism, not a demonstrated mechanism of the final dosage form. Ginger constituents such as gingerols and shogaols may contribute antioxidant and anti-inflammatory effects and may support mucosal tolerance in relevant experimental models. Liquorice constituents, including glycyrrhizin-related compounds and flavonoids, may contribute mucosal, antioxidant and inflammatory modulation. The antacid may neutralize part of the luminal hydrochloric acid and reduce acid-peptic aggression. The floating matrix may prolong gastric residence and provide controlled release. The expected outcome is a potential multi-mechanistic local gastric platform, but proof requires release studies, tissue-level pharmacology, animal studies and appropriately designed clinical research.

12. Advantages

Potential advantages include prolonged gastric contact, integration of physicochemical acid neutralization with botanical research hypotheses, controlled release, reduced dosing frequency, possible local action and a rational platform for studying natural products. A single tablet may also improve convenience compared with separate administration of an antacid and herbal preparations. These are anticipated formulation benefits, not established clinical outcomes.

13. Limitations

The main limitations are variability in botanical identity, cultivation, harvest, drying, extraction and storage; difficulty standardizing multiple constituents; possible degradation or interaction during compression; limited dose capacity; gastric motility variability; and uncertainty regarding the in-vivo relationship between buoyancy and mucosal exposure. Antacid components may alter extract solubility or stability and may interact with concomitant medicines. The combined Ginger–Liquorice floating antacid tablet has limited direct formulation-specific evidence in the 2020–2026 literature identified for this review. Pharmacological, toxicological, in-vivo and clinical validation remain necessary.

14. Safety Considerations

Liquorice requires particular caution. Excessive or chronic glycyrrhizin exposure may inhibit 11β-hydroxysteroid dehydrogenase type 2 and produce sodium retention, potassium loss, edema and elevated blood pressure; cardiac rhythm disturbances may occur in susceptible individuals. The EMA advises avoidance or medical supervision in people with hypertension, renal, hepatic or cardiovascular disorders or hypokalaemia, and cautions against prolonged use.[23] A proposed product should therefore specify glycyrrhizin exposure, treatment duration, contraindications and warnings.

Antacid precautions depend on the salt. Aluminium- and magnesium-containing products can affect bowel function and may bind or reduce absorption of other medicines. Calcium- or sodium-containing products require consideration of calcium load, sodium intake and acid–base effects. Ginger is generally well tolerated as food, but concentrated extracts require dose-specific safety assessment and interaction review. The final product should not be recommended for persistent symptoms, gastrointestinal bleeding, severe pain, recurrent vomiting, unexplained weight loss or suspected ulcer complications without medical evaluation.

15. Recent Developments (2020 onward)

Recent gastroretentive research has expanded beyond conventional compressed floating tablets. Reviews discuss floating, mucoadhesive, expandable, raft-forming, high-density and magnetic systems and emphasize the influence of physiological conditions, polymer selection and manufacturing strategy.[11–16] Recent studies have explored swellable floating systems, controlled-release combinations, 3D-printed devices, polymeric excipients and advanced manufacturing methods.[27–32] These developments support more precise control of geometry, porosity, buoyancy and release, although they do not remove the need for in-vivo confirmation.

Natural-product research has increasingly examined standardized extracts, nano- or micro-carriers and plant-derived systems. Ginger reviews continue to describe gastrointestinal, antioxidant and anti-inflammatory evidence, with concern about heterogeneous

preparations and incomplete clinical validation.[1–4,17–19] Liquorice literature similarly emphasizes multi-target pharmacology, glycyrrhizin metabolism, delivery-system opportunities and toxicity.[5–8,20–22] In antacid science, recent work has focused on comparative ANC and artificial-stomach models, illustrating that composition and dosage form influence onset and duration.[24,25,33]

Table 6: Summary of Selected Recent Literature Directions and Their Relevance.[1–8,11–16,22,24,25,27–33]

Area	Recent literature direction	Relevance to proposed system
Gastroretentive systems	Floating, swellable, mucoadhesive, raft and expandable approaches	Provides design options and evaluation principles.
Advanced manufacturing	3D printing, hot-melt extrusion and geometry optimization	May enable precise porosity and release, but is not required for an initial tablet study.
Natural products	Standardized extracts, nanoparticulate delivery and mechanistic studies	Highlights the need to control botanical composition and bioavailability.
Antacids	ANC testing and artificial-stomach models	Supports time-resolved evaluation of neutralization, not only endpoint pH.
Herbal gastric protection	Preclinical models using ginger or Liquorice-derived materials	Provides rationale but does not establish efficacy of the combined floating tablet.

16. Research Gap

A focused search identified literature on Ginger, Liquorice, antacids and gastroretentive systems separately, but not convincing 2020–2026 evidence establishing a standardized combined Ginger + Liquorice floating antacid tablet with reproducible pharmaceutical, pharmacological and clinical outcomes. Older work has reported floating tablets containing Liquorice extract, but this does not validate the present combination or current development requirements.[34] The principal gaps are:

- Need for authenticated, standardized Ginger and Liquorice raw materials and extracts.
- Need to quantify glycyrrhizin and selected Ginger constituents and define batch specifications.
- Need for compatibility, moisture-protection and stability studies for the botanical–antacid–polymer system.
- Need for optimization of buoyancy, swelling, release and ANC under physiologically relevant conditions.
- Need to determine whether the combination is additive, merely complementary or antagonistic in validated models.
- Need for in-vivo gastric-retention, mucosal-histology, pharmacodynamic and toxicological studies.
- Need for appropriately designed clinical studies before any claim of clinical gastroprotective efficacy.

17. Future Perspectives

Future work should begin with botanical authentication, controlled extraction and a justified glycyrrhizin exposure limit. A quality-by-design strategy could examine polymer level, acid–base ratio, tablet compression, extract loading and packaging as critical variables. In-vitro work should integrate ANC, floating force, total buoyancy, swelling, release and stability rather than treating each test independently.

Subsequent pharmacological studies should compare the individual extracts, the combination, the antacid alone and the complete formulation in validated gastric-injury models. Pharmacokinetic or tissue-distribution studies may clarify whether prolonged buoyancy changes local exposure. If results remain promising, clinical investigation should use standardized product specifications, clinically meaningful endpoints and explicit safety monitoring, especially blood pressure and serum potassium for glycyrrhizin-containing products.

CONCLUSION

A floating antacid tablet containing Ginger and Liquorice is a scientifically plausible formulation concept built on three distinct ideas: direct acid neutralization, potential botanical antioxidant/anti-inflammatory and mucosal effects, and prolonged gastric residence through buoyancy. Current literature provides supporting evidence for the individual ingredients and for gastroretentive technologies, but it does not establish that the proposed combination is clinically effective or synergistic. Development should therefore proceed as a staged pharmaceutical research program involving standardized materials, compatibility and stability studies, ANC and buoyancy testing, controlled release characterization, pharmacological validation and, only if justified, clinical investigation. Careful control of glycyrrhizin exposure and antacid-related precautions is essential.

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