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Herbal Antacid Chewing Gums: A Comprehensive Review On Natural Therapeutics, Formulation, Evaluation and Patent Landscape

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ABSTRACT

Herbal antacid chewing gum is becoming popular as one of the simplest and most patient-compliant ways to treat acidity and related stomach issues. Safe and convenient therapy appears to be in demand given the prevalence of illnesses like GERD (gastroesophageal reflux disease), etc. The advantages of using natural herbal remedies in conjunction with chewing gum therapy seem to be a practical approach. Saliva secretion increases the gastric acid's buffering effect during chewing, ensuring a gradual release of the active substances. This review highlights few of the popular used herbal agent used as antacid and gastroprotective and explains the role of herbs in managing acidity. Different strategies for formulating are discussed along with significant materials and preparation techniques. Few significant parameters to be measured are discussed like acid neutralizing capacity, drug release, texture, stability. Available patents, future prospects are briefly discussed. In conclusion, it can be stated that chewing gums for antacids using herbal agents offer a good substitute.

Keywords: Herbal antacid chewing gum, gastroprotective activity, acid neutralization, herbal formulations, chewable dosage form.

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INTRODUCTION

Food over consumption, changes in lifestyle and stress have contributed to increasing incidence of acid related disorders such as hyperacidity and gastroesophageal reflux disease (GERD). The effect on the patient's life style may be adverse and may lead to other disorders if unattended.[1] Tablets and liquid suspension antacids are readily available commercially and offer symptomatic relief from acid related disorders within a short time. These forms however are required to be consumed with water, exhibit short duration of action, which can be a problem during travelling or those leading an otherwise busy life. [2–5]

In recent years, there has been a growing interest in innovative medication delivery systems that are both practical and effective. One significant innovative delivery method is medicated chewing gum (MCG). MCGs are solid dose forms that can be chewed but not swallowed. [6–9] When the MCG is chewed, the active medications are delivered into the oral cavity at a regulated rate. The act of chewing itself produces more saliva. [10] Naturally occurring bicarbonate ions in saliva aid in the clearance from the esophagus and neutralize the acids in the stomach. [11–13]

Besides this, there is an increasing tendency to use herbal and natural treatments, due to its relative safety and few side-effects. Various medicinal plants, for example, licorice, ginger and bael has already exhibited gastroprotective and anti-ulcer effects hence a potential candidate to be used in antacid formulations. [14] Thus combining herbal constituents with chewing gum based systems gives us the best of both world-nature's therapy and advanced drug delivery.

Additionally, chewing gum offers the benefit of being easy to administer, enhancing patient compliance, the availability to deliver an adequate dose to the systemic circulation and the controlled release of the drug. [15–17] Hence, chewing gum is an attractive dosage form for the chronic treatment, such as GERD, where regular medication intake is essential. The development of improved formulation methods, together with the growing research interest, indicate that the herbal antacid chewing gum can emerge as an interesting and dynamic field of pharmaceuticals.

Herbal Ingredients with Antacid Potential

Medicinal plants have gained a crucial position in the treatment of various gastric affections including acidity, indigestion and ulcer. Unlike synthetic antacids, these drugs work mostly by rendering gastro-protection, minimizing inflammation, repairing tissues etc., leading to antacid effect. [18–21]

Glycyrrhiza glabra (Liquorice):

The root of the plant *Glycyrrhiza glabra* is considered as the one of the widely used plant in herbal formulation. In the root extract the most therapeutic importance and activities belong to

Flavonoids, Saponins and Glycyrrhizin. All these possess profound ulcerogenic and antiulcer activities and they protect the mucosa against ulceration by maintaining the gastric mucosal barrier and increases gastric secretion of mucus, decrease the acid-peptic damages, heals the gastric and duodenal ulcers due to increasing mucosal defense and prostaglandin synthesis.[22]

Figure 1: Root of liquorice

***Aegle marmelos* (Bael):**

Bael is a medicinal plant *Aegle marmelos*. It is a member of the *Rutaceae* family. The fruit widely used. It has a lot of good things in it like tannins and marmelosin. The fruit Aegle marmelos has good properties for the stomach. Aegle marmelos relieves ulcers. It keeps the stomach safe. It helps with digestion and regulates the production of acid in stomach. It can help make people with a lot of acid in their stomach feel better. The tannins present in bael can help to develop a protective layer on the gastric mucosa and it also helps to reduce inflammation of the stomach. This herb is also good in digestive effects so can be included in antacid composition. [23]

(A) **(B)** **(C)**

Figure 2: Aegle marmelos (Bael): (A) Fruit-bearing plant, (B) Fresh fruit, and (C) Dried fruit

***Musa paradisiaca* (Banana):**

Musa paradisiaca L. (Banana), belongs to *Musaceae* family, immature fruit is utilized for stomach ailments and possesses qualities which include being rich in pectin, polysaccharides and certain bioactive components. Banana has a mild antacid and gastroprotective properties through elevation of gastric pH and forming a protective film layer on stomach. Polysaccharides in banana can strengthening the mucosal barrier and reducing stimulation by protecting stomach against stomach

damage by acid. Banana was also found to be responsible for enhancing ulcer healing and has good effects on the digestive system so as to use as a useful agent to cure hyperacidity. [24]

(A) (B) (C)

Figure 3: Musa paradisiaca (Banana): (A) Banana plant with fruits, (B) Fresh unripe fruits, and (C) Dried fruit slices

***Zingiber officinale* (Ginger):**

Zingiber officinale (Ginger) in the family *Zingiberaceae*, has long been employed as a medicine and continues to be used by both traditional and conventional medicine practitioners. Biologically active constituents in ginger include gingerols, shogaols and zingerone, which provide its health benefits. Although ginger does not neutralize gastric acid, it has therapeutic applications to mitigate the symptoms arising from acidity. It serves its purpose by assisting in gastric emptying, facilitating the digestive processes and calming irritation of the stomach and nausea. Ginger's ability to be anti-inflammatory and antioxidants contribute to it being a gastroprotectant and a beneficial element of herbal antacids, because of the protective properties it affords to the gastric mucosa. [25,26]

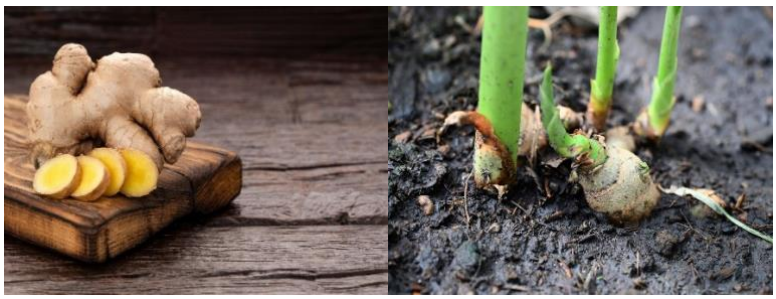
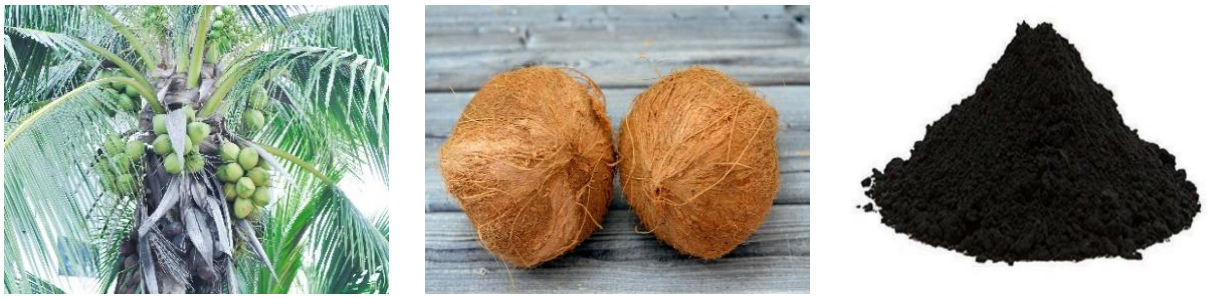


Figure 4: Zingiber officinale (Ginger): (A) Fresh rhizome and (B) Ginger rhizome

***Cocos nucifera* (Coconut shell ash):**

Coconut (Cocos nucifera) is a palm belonging to the family of *Arecaceae*. Coconut shell ash has a basic mineral content and has been considered a natural antacid for a long time. Coconut shell ash contains various types of salts with a mineral component, which helps to have ability in neutralizing acid. Different from most herbal agents providing merely gastro-protection effects, the coconut shell ash has direct antacid action because it directly neutralizes the extra gastric acid and

rises pH of the stomach. Direct neutralizing effect relieves hyperacidity, heartburn and gastric pain. It is known to have a characteristic as natural source and has an alkali content, not present in most herbal antacid ingredients. [27]



(A) (B) (C)

Figure 5: Cocos nucifera (Coconut): (A) Coconut palm bearing fruits, (B) Coconut shell, and (C) Coconut shell ash

***Mentha piperita* (Peppermint):**

Mentha piperita (peppermint) which comes under the family *Lamiaceae* consists of aromatic leaves which contains abundant quantities of menthol and volatile oils to induce an immediate chilling effect and a sensation of relief. Peppermint is widely used as carminative, antispasmodic, digestive. It acts by relaxing smooth muscle of gastrointestinal tract that reduces gastric discomforts, bloating, indigestion. It also increases ease of gastric emptying and increases palate ability in herbal preparations even though it is not an acid neutralizing agent but it increases comfort. It's refreshing taste also increases patient acceptance. The cooling flavor it increases patient compliance when incorporated in meditated chewing gum. [28]

Figure 6:Mentha spp. (Mint)

***Foeniculum vulgare* (Fennel):**

Foeniculum vulgare commonly known as fennel belongs to *Apiaceae* family and the seed is often used to aid digestion. Seeds of fennel consist main active ingredient anethole which forms the majority component of the seeds as well as a range of essential oils and flavonoids. This herb has a known carminative and digestive action, to relieve symptoms of flatulence, bloating and slight gastric pains. Fennel aids digestion by promoting and increasing motility of the digestive tract, it

also has antispasmodic effects on the digestive system. Although its effect is not direct antacid-based; but it plays an important role in antacid Herbal medicines and medicated chewing gums due to its role in digestion & acidity management. [24]

Figure 7: Foeniculum vulgare (Fennel)

***Ocimum sanctum* (Tulsi):**

Ocimum sanctum commonly referred as tulsi or holy basil is a herb of *Lamiaceae* family that consist of variety of bioactive constituent in their leaves, such as eugenol, Flavonoids, essential oils which shows it medicinal properties. The activities shown by the tulsi include very potent anti-ulcer, antioxidant and gastroprotective activities. The anti-ulcer effect is by the activation of gastric protective mechanisms, along with the reduction of oxidative damage. Also reduces the inflammatory processes and ulcer healing of the gastric lesions that leads to reduce the intensity of acid dependent diseases. Thus, tulsi can be regarded as a highly effective herbal constituent to be used in gastroprotective and antacid preparation.

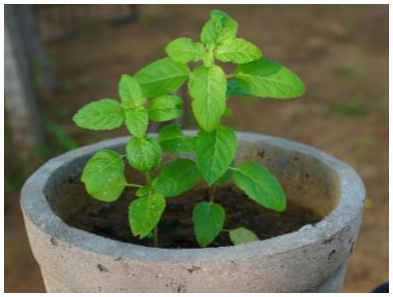


Figure 8: Ocimum sanctum (Tulsi)

Mechanism of Action of Herbal Antacid Agents

Most differences in the action of conventional and herbal antacid preparations lie in the therapeutic actions in relation to conventional antacid agents, that exert their main action through chemical reaction-based neutralizing capacity of gastric acid, herbs mainly achieve therapeutic effects by acting through multiple gastroprotective mechanism, namely mucosal protection enhancement, regulation of gastric acid secretion, antioxidant action, anti-inflammatory properties, control of gastric emptying and wound healing property.

Liquorice:

Licorice has its gastroprotective effect predominantly by inducing the synthesis and increasing thickness of gastric mucin and the protective role against erosion induced by strong stomach acid. Its ability to raise gastric prostaglandins and improve the rate of repair of gastric lesions is important for its gastroprotective effect.

Bael:

Bael can be used for acidity due to its capacity to control the gastric secretion and regulate the rate of excessive acid production. Bael also shows the presence of a higher concentration of tannins that not only exhibit gastroprotective nature by helping to prevent the injury of stomach lining, but also possess anti-inflammatory properties for the gastric lining, thereby helping in better mucosal integrity due to presence of anti-oxidant moieties.

Banana:

Banana exerts its protective action on gastric tissues via different mechanisms that enhance gastric mucosa, such as formation of a layer on gastric lining; increases resistance; decrease incidence of lesion. Polysaccharides in banana decrease and alleviate gastro irritation and injury; and maintain healing property. Banana also possesses some gentle buffer capacity and could ease hyperacidity due to decrease gastric pH.

Ginger:

Ginger works mostly on its basis of anti-inflammatory and digestive. Ginger inhibits the production of pro-inflammatory molecules responsible of the irritation and stomach discomfort. It favors an increase of the stomach evacuation speed and the gastrointestinal transit for a more comfortable digestion and an optimal treatment of hyperacidity discomfort (bloating, reflux etc.).

Coconut shell ash:

Coconut shell ash functions as a direct antacid with their alkaline mineral components readily neutralize the excess gastric acid by forming stable reaction products which leads to a sharp increment of gastric PH with rapid resolution of acidity and Heartburn. This is similar to action of traditional antacids. It is also a type of natural agent that directly act as an antacid.

Peppermint:

Peppermint helps to ease the stomach pain (gastralgia), due to the effect soothing and antispasmodic action of its chief constituents (the principal being menthol, the substance which possesses relaxant effects on intestinal smooth muscles) while on overall effect relieves digestive spasms, bloating, and also induces a cooling effect, which can be pleasing to patients and improve acceptability.

Fennel:

The effects of fennel can primarily be attributed to their carminative and digestive properties, such as aiding the movement of food through the gut, decreasing the formation of gases, and relieving bloating and abdominal pain. Improved digestive function and reduction of gastrointestinal problems assist in the relief of mild acidity and dyspeptic symptoms indirectly.

Tulsi:

It plays a vital gastroprotective role through its antioxidant and anti-ulcer activity. It acts to decrease reactive oxidative species by using its radical scavenging action in and around the mucosa and also by enhancing endogenous antioxidant defence, the gastric tissue can be well protected from acidic irritation with improved healing capacity, ulcer-inhibiting, and anti-inflammatory actions and thus can protect the inner stomach wall from damage by acid.

FORMULATION STRATEGY OF HERBAL ANTACID CHEWING GUM

In the preparation of herbal medicated chewing gum proper selection of excipients is the most crucial step as these excipients are responsible for the release of the drug uniformly and at a slow rate, desirable taste and texture and most importantly patient compliance. Conventional melting process or direct compression method may be employed in this method and it is generally advisable to employ direct compression for heat labile herbs.

Table 1: Excipients Used in Herbal Chewing Gum and Their Roles

Excipients	Role	Examples
Gum base	• Matrix of the chewing gum. • Responsible for the elasticity of the article, cohesive force, chewy texture. • Slow release of actives while masticating[29].	Bees wax, chile, gum arabic, pectin, guar gum.
Sweeteners	• It masks bitterness of the herbal extracts and enhance palatability. • May also contain some additional dental benefits. • Some have added benefits for teeth[30].	• Bulk sweeteners: Sorbitol, xylitol mannitol, isomalt. • Intense sweeteners: sucralose, aspartame, • Natural sweeteners: Honey powder, jaggery powder, stevia.
Mannitol	• Acts as a filler and bulking agent. • Gives cooling effect. • Helps in mouth feel and in the total sensory experience of chewing gum.	• Spray-dried mannitol, powdered mannitol granulated mannitol, liquid mannitol solution.
Plasticizers	• Ensure gum flexibility and softness. • Protect from becoming hard and brittle in storage. • Enhances its chewiness, texture and complete incorporation of the ingredients into formulation.	• Propylene glycol, glycerin, polyethylene glycol (PEG), lecithin.

Flavoring agents	• Improves flavor, masks any bitter/herbal flavors. • Cooling or refreshing properties. • Increase patient compliance.	Clove oil, lemon oil, orange oil, cardamom oil, fennel oil, peppermint oil, spearmint oil.
Lubricants	• Enhanced Powder flow during manufacturing. • Reduce friction during compression. • Prevents stickiness of punches and dies. • Provides Smoothness in process.	Magnesium stearate (2%), Calcium stearate, stearic acid, talc (1-2%), sodium stearyl fumarate.

APPROACHES TO MANUFACTURING HERBAL CHEWING GUM FORMULATIONS

Direct Compression method:

Direct compression method is an easy and inexpensive method for preparation of medicated chewing gums in which powder form of the gum base is mixed with the herbal active ingredient, sweeteners, fillers, flavours, lubricants and other excipients to form a homogeneous mass, which is then compressed in a tablet compressing machine to obtain uniformly weighted and containing units of chewing gum. This method is best suited for thermolabile herbal compounds due to no heat treatment. [31]

Conventional melting method:

The usual method of preparation by melting process, wherein the gum base is heated and softened under controlled temperature. When the gum base has softened sufficiently, herbal material along with the sweeteners, plasticizers and other excipients is mixed in[28]. All the constituents are well mixed. Then mass is cooled, rolled and sheeted or shaped as required. Heat sensitive materials (like essential oil) are usually mixed in when mass has cooled down in order to prevent loss of these ingredients due to volatile nature. [32,33]

Special considerations:

- Peppermint oil, be added at the cooling phase to avoid its volatility.
- Herbal powders like Banana, Bael, fennel can be added at mixing phase.
- Extracts like Liquorice, Ginger, Tulsi to ensure uniform distribution so that content is uniform.
- Coconut shell ash, ground properly to attain fine powder should be used.

EVALUATION PARAMETERS OF HERBAL ANTACID CHEWING GUM

In order to determine if herbal antacid chewing gum is acceptable pharmaceutically, has proven activity in vivo throughout the intended shelf-life and is stable over time, it is necessary that the chewing gum formulation is evaluated. However, the evaluation of a chewable form like the gum

formulation necessarily involves assessment of mechanical attributes, in addition to assessing pharmacological actions for the treatment of indigestion. [7,9,12]

- **Organoleptic evaluation:** The formed herbal antacid chewing gum product was assessed for its organoleptic properties with the help of volunteers. Volunteers evaluated the product based on their perception of appearance, colour, odour, taste, texture, mouthfeel, after taste and acceptability of product. Volunteers were chewed the gum in a usual manner and make observation based on bitter-masking properties, cooling sensation, chewing qualities and texture. Product will be judged satisfactory if having appearance and taste are pleasing, odour is agreeable and having smooth texture with no grit and bad after taste.
- **Weight variation test:** Weight of individual chewing gum unit is calculated for having uniform masses. 20 units were selected at random and they were weighed one by one on an electronic balance. From the average weight and the weight of individual unit, percentage deviation for each unit from the average weight was determined. Values were compared according to the pharmacopeial test for any variability in the Manufacturing of dosage units and to check the consistency in the uniformity of the dose
- **Hardness and texture analysis:** Analysis of hardness and textural properties were performed on a texture analyzer with a standard probe. Each of individual piece of gum was tested to controlled compression by means of their resistance (i.e., hardness, adhesiveness, cohesiveness, elasticity and chewability) to mechanical disruption. This study was designed to investigate the mechanical properties of gum. Texture evaluation may verify satisfactory texture properties of the formulation.
- **Friability test:** The Friability was performed to evaluate the tendency of the chewing gum formulation to mechanical forces experienced during manufacturing processes of packaging, handling and transporting it. Chewing gum pieces were preweighed into a friabilator apparatus and rotated at a standard speed for a set time. At the conclusion of the testing, the chewing gum pieces were dedusted and then reweighed and percentage of loss of mass was calculated as a measure of mechanical resistance of the composition. [34]
- **Content uniformity:** The uniformity of content analysis was carried out to establish uniform distribution of the active herbal ingredient in chewing gum unit. The test consisted of selecting the chewable units at random and testing individually with UV-visible spectrophotometry or liquid chromatography. From the content uniformity analysis, concentration of each constituent is calculated and compared with the declaration for adequate dose.

- ***In-Vitro* drug release study:** *In-vitro* drug release studies were performed on either a chewing simulator or a specially adapted dissolution apparatus which simulated the process of chewing the gum. A unit of chewing gum was added to the dissolution medium which was maintained at body temperature, the chewing simulation apparatus operated at the appropriate set of conditions and samples removed at fixed time points and assay for their drug content by any standard analytical method. Cumulative percent drug release was calculated for analysing the release profile of the active drug from the chewing gum formulation. [35]
- **Acid neutralizing capacity:** The acid neutralizing capacity of chewing gum was measured by back titration method. Measured amount of chewing gum was reacted with fixed volume of standardized hydrochloric acid (HCl) solution under a fixed condition. On completion of reaction unreacted acid in solution was titrated with standard sodium hydroxide (NaOH) solution using phenolphthalein as indicator and acid neutralized was calculated in milli equivalents (mEq) / dose. This is used for antacid study. [36]
- **pH:** pH Determination for the formulations was investigated to assess their potential as Oral formulations. A fixed weight of chewed gum was soaked in a suitable buffer solution or simulate saliva and stirred at certain duration of time. The pH of this solution was then recorded using digital pH meter (calibrated properly) in three replicate measurements and averaged.
- **Stability studies:** The stability studies were performed as per ICH guidelines to evaluate the physical and chemical stability of the formulation under various storage conditions. The chewing gum samples were filled into suitable containers and placed in for long-term (25±2ºC/60±5% RH) and accelerated studies (40±2ºC/75±5% RH). Samples were withdrawn at various time points and subjected for the parameters such as appearance, taste, texture, pH, drug content and acid neutralizing capacity. Changes over the time period were compared with initial observations for stability determination of the formulation. [37]
- **Microbial limit test:** To ascertain microbiological quality of herbal antacid chewing gum formulation. Microbial limit test was undertaken. The herbal antacid chewing gum formulation was first suspended to a measured amount in a sterile diluent and screened and investigated for total aerobic bacterial count and total yeast and mold count following a standard plate count. Furthermore, the formulations were screened for the existence of

certain objectionable and pathological organism, on the basis of selective differential culture media, compared to the specifications given in the pharmacopoeia.

RECENT ADVANCEMENTS:

New advancements have helped move technology in medicated chewing gums forward for things other than your routine oral care or for stop smoking purposes. Current efforts of the current study are concentrated at designing of medicated gums which can be use as the carrier system for the drugs. The major challenge faced in developing medicated gum include improved bioavailability, patient compliances of medicated chewing gums, novel technology used for formulation which includes taste masking by cyclodextrin inclusion complex; directly compressible gum base formulation, controlled release systems which show improved release of drug, and Palatability. Further in present, studies the incorporation of medicinal plant extracts in the formulation for their natural source, safety & therapeutic properties also carried out. Beside this in the recent development studies nanoencapsulation, self-emulsifying drug delivery system and an optimized formula for the stability and bioavailability of plant derived active principles by using AI & digital formulation design have also revealed encouraging results[18,31,38–40].

Among medicated chewing gum technology developments, recent patents describe gum base compositions that improve delivery of drugs via novel formulations; innovative processes for compressional binding and formation of drug tablets by means of masticable gum; drug stability and bioavailability improvements by using medicated chewing gum with specific flavour system that successfully masks the taste of potent agents and; gum formulation that allow controlled and effective released of APIs during oral ingestion. These developments could be applied to the development of medicated gum for delivering drugs for oral diseases, smoking cessation, pain treatment, gastro-intestinal disorders or systemic drug administration. This review examines new gum technology patents and discuss advancements in manufacturing processes that have increased gum quality, improved shelf-life and enhanced patient acceptability thus allowing the development of this therapeutic tool with considerable commercial potential. [41]

Recent patents on herbal medicated chewing gums are as follows:

Table 2: Recent Patents on Herbal Medicated Chewing Gums

Sl. No.	Patent Number	Year	Title	Herbal/Active Ingredient	Applicant/Assignee
1	CN111296616A	2020	Chewing Gum Containing Plant Extract and Preparation Method Thereof	Plant extracts (various botanical extracts)	Guangdong Dapeng Medicine Technology Co., Ltd.[42]

2	US20220023203A1	2022	Method for Manufacturing Medicated Chewing Gum without Cooling	Applicable to herbal and pharmaceutical actives	Per Os Biosciences LLC[43]
3	SE2450053A1	2025	Natural Chewing Gum with Nicotine and Manufacturing Method	Natural gum base with naturally derived nicotine	Inventor/Applicant (Sweden)[44]
4	US12594235B2	2026	Intraoral Cleaning Tablet (Chewing Gum Composition)	Apple peel extract, fermented apple peel, gum acacia, vitamin E, stevia, peppermint oil	Frank Rees[45]

CONCLUSION:

Herbal antacid chewing gums, innovative, convenient and patient compliance option for treatment of hyperacidity, acid-related disorders. Traditionally antacids act by neutralizing the gastric acid. However, herbal active constituents exert their effect in different ways such as improvement in mucosal protection, antioxidative activity, anti-inflammatory activity, regulation of acid secretion and ulcer healing activity. Licorice, banana, bael, ginger, coconut shell ash, mint, fennel, tulsi etc. Have potent therapeutic property, which can be incorporated into medicated chewing gums. The unique features of chewing gum delivery system make it desirable due to palatability, patient compliance, ease of administration and sustained local release effect. Suitable selection of excipients and proper designing of manufacturing techniques and evaluation of chewing gum formulation will also help in delivering effective dosage forms. The medicinal chewing gum for the relief of acid-related disorders through natural route can be a new development in the future.

Conflict of interest: Authors do not have any conflict of interest.

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