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"A COMPREHENSIVE REVIEW ON THE ACIDITY SUPPRESSING EFFECT BY USING *PEPPERMINT* LEAVES AND *ALMOND* FRUIT"

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Abstract:
This review explores the acidity-suppressing effects of *peppermint* (*Mentha piperita L.*) and raw almonds (*Prunus dulcis*). *Peppermint*, with its rich phytochemical profile, exhibits significant anti-inflammatory, antimicrobial, and antispasmodic properties, which can alleviate gastrointestinal discomfort and reduce acidity. Its active components, such as menthol and menthone, play a crucial role in relaxing the esophageal sphincter, reducing intracolonic pressure, and minimizing the symptoms of gastrointestinal disorders like GERD (Gastroesophageal Reflux Disease). Raw almonds, known for their high content of bioactive compounds such as flavonoids and phenolic acids, also demonstrate anti-inflammatory and antioxidant activities that contribute to their acid-neutralizing properties. The review highlights the potential of these natural remedies in managing acidity and promoting digestive health, emphasizing the need for further clinical studies to validate these effects.

Keywords: *Peppermint*, Raw Almonds, Acidity, GERD, Gastrointestinal Health, Phytochemicals, Anti-inflammatory, Antioxidant.

1. Introduction

1.1 Introduction to GIT

The gastrointestinal tract (GI tract, digestive tract, alimentary canal) is the tract or passageway of the digestive system that leads from the mouth to the anus. The GI tract contains all the major organs of the digestive system, in humans and other animals, including the esophagus, stomach, and intestines.

The human digestive system is the system that allows the human body to digest food. The digestive tract, or the chain of structures and organs through which food and liquids pass

while being processed into forms that may be absorbed into the bloodstream, is the primary component of the human digestive system. The system also includes the structures through which wastes flow during elimination, as well as organs that provide juices required for digestion.

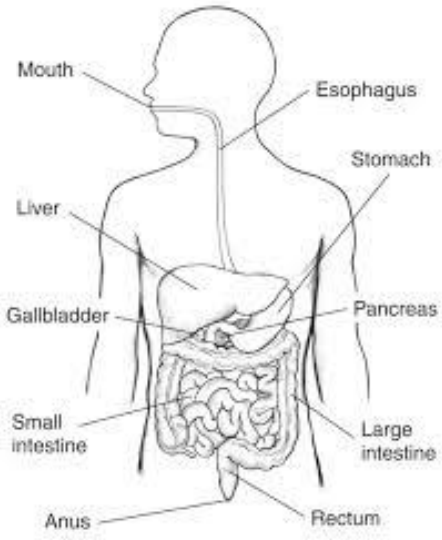

Figure 1 Human Digestive System

Nutrients are required by the human body for healthy functioning. Some of these nutrients act as raw materials for the creation of cellular components, while others help regulate chemical reactions or, when oxidized, produce energy. Many nutrients, however, are in an improper condition for immediate usage by the body; to be beneficial, they must undergo physical and chemical transformations, which are aided by digestion.

The digestive tract starts from the lips and finishes at the anus. It consists of the mouth, or oral cavity, with its teeth, for grinding the food, and its tongue, which serves to knead food and mix it with saliva; the throat, or pharynx; the esophagus; the stomach; the small intestine, consisting of the duodenum, the jejunum, and the ileum; and the large intestine, consisting of the cecum, a closed-end sac connecting with the ileum, the ascending colon, the transverse colon, the descending colon, and the sigmoid colon, which terminates The salivary glands, the gastric glands in the stomach lining, the pancreas, and the liver and its associated organs—the gallbladder and bile ducts—all contribute digestive fluids. All of these organs and glands contribute to the physical and chemical breaking down of ingested food and to the eventual elimination of non-digestable wastes. [1]

The principal functions of the digestive system are preparation of food for cellular utilization, elimination of bile secretion from the liver and voiding of undigested food material. Although these functions require numerous complex interrelated physiologic processes, the basic digestive activities are:

1. ingestion (the intake of food into the GI tract by way of the mouth)
2. mastication (chewing movements to pulverize food and mix it with saliva to form a bolus)
3. deglutition (swallowing to move the bolus from the oral cavity to the stomach)
4. digestion (mechanical degradation, liquefaction and enzymatic hydrolysis so that nutrient molecules within the chyme are broken down)
5. absorption (passage of molecules of food through the mucous membrane of the small intestine and into the circulatory or lymphatic systems for distribution to cells)
6. peristalsis (rhythmic, wavelike intestinal contractions that move food through the gastrointestinal tract)
7. Defecation (the discharge of indigestible wastes, called feces, from the digestive tract). [2]

1.2 Introduction to Acidity

The English word "ulcer" is derived from the Latin word ulcus (genitive ulceris), which means "sore, wound, or ulcer," therefore peptic ulcer literally denotes tissue corrosion in the digestive system. Gastroesophageal Reflux Disease (GERD) occurs when the liquid contents of the stomach, in the form of acidic digestive juices, flow back into the esophagus. Acidity refers to a medical

disorder in which the liquid in the stomach turns into too much acid. Gastric ulcers occur when there is an imbalance between the digestive juices produced by the stomach and the many elements that protect the stomach's mucosal lining.[3]

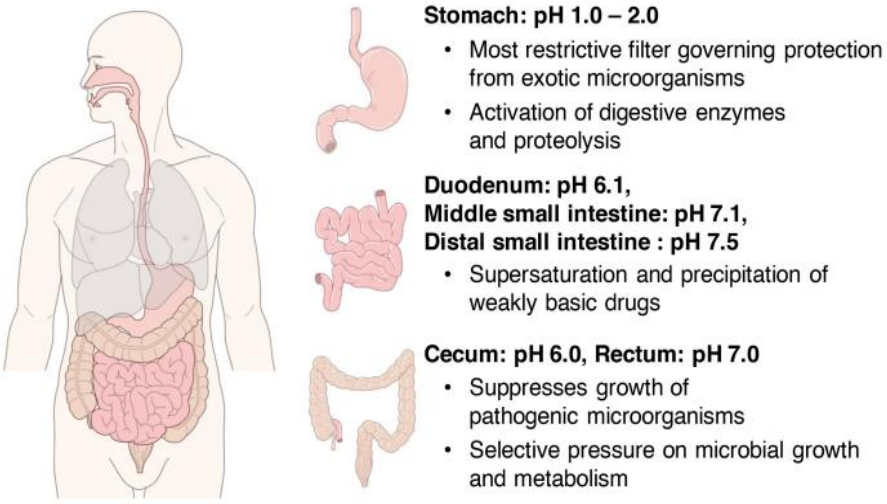

Figure 2 pH of different parts of digestive system

Distribution of pH in the gastrointestinal tract. In the stomach, strong bactericidal action is necessary, and gastric juices have a fairly strong acidity at pH 1.0–2.0 (upper right). The pH of the intestinal lumen increases on average to 6.1 in the duodenum, 7.1 in the middle small intestine, and 7.5 in the distal small intestine (right middle). Thereafter, the pH temporarily reduces to approximately 6.0 near the cecum at the entrance of the large intestine and increases toward the rectum and becomes around 7.0 near the exit of the large intestine (lower right) [4]

1.3 Symptoms:

- Burning stomach pain: This is the most common symptom and often worsens with an empty stomach.
- Bloating and belching: Feeling full too soon during a meal or uncomfortably full after eating.
- Nausea and vomiting: Sometimes accompanied by vomiting blood or dark, tarry stools.
- Heartburn: A burning sensation in the chest.
- Appetite changes: Unexplained weight loss and changes in appetite

1.4 Causes of Peptic Ulcers:

- Helicobacter pylori (H. pylori) infection: leads to an inflammatory reaction, epithelial cell degeneration, and damage.
- Non-steroidal anti-inflammatory drugs (NSAIDs): cause injury to the duodenal and gastric mucosa by penetrating the mucus layer, reducing prostaglandin production, and inhibiting cyclooxygenase (COX) enzymes.
- Other factors: alcohol, smoking, cocaine, severe illness, autoimmune problems, radiation therapy, and Crohn's diseas.

1.5 Pathophysiology:

- Helicobacter pylori (H. pylori) Mechanism:

1. Inflammatory reaction: neutrophils, lymphocytes, plasma cells, and macrophages damage the mucosa.
2. Epithelial cell degeneration and damage: leads to gastritis and peptic ulcers.

- NSAID Mechanism:

1. Penetration of mucus layer: weak non-ionized acids damage the mucosa.

2. Cyclooxygenase (COX) inhibition: reduces prostaglandin production, leading to: Decreased mucus and bicarbonate production, Suppressed cell proliferation, Decreased mucosal blood flow.
3. Systemic and local mechanisms: NSAIDs damage the mucosa through both pathways.
Other Factors are stress: leads to stress ulcers, diet: skipping meals, coffee, and caffeine may contribute to peptic ulcers, Smoking and alcohol: disrupt gastric mucosal barriers, increase free radical secretion, and decrease cyroprotective prostaglandin secretion. [5]

2. DETAILED PLANT STUDIES:

2.1. *Mentha piperita L.*

2.1.1 Taxonomical Classification: [6]

Kingdom	Plantae plants
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Lamiaceae
Genus	Mentha
Species	Piperita
Binomial Name	*Mentha piperita L.*

2.1.2 Vernacular Names of *Mentha piperita L*: [7,8,9]

- **Sanskrit**: Pudhina , Puthia
- **Hindi**: Pudina
- **Gujarati**: Phudino
- **English name**: brandy mint or *peppermint*

2.1.3 Geographical Distributions:

The herb is mainly indigenous to Europe and widely spreads in all over the world. It is found in Australia, Asia, Galapagos islands, New Zealand, United States, and India.[9]It is widely grown in temperate areas of the world, particularly in Europe, North America and North Africa but nowadays cultivated throughout all regions of the world.[10] The cultivation of Japanese or corn mint originated from Brazil and China. Subsequently, China and India overtook Brazil and more recently India has taken the leading position in cultivation of this essential *Peppermint* plant [11]. *Peppermint* is cultivated in large areas of the Ganga plains of Uttar Pradesh, Punjab, Haryana, and Bihar. Seventy-five per cent of the crop is grown in Uttar Pradesh, 15% in Madhya Pradesh and Bihar, 5% in Uttarakhand and the remaining 5% in Punjab and Haryana [12].

2.1.4 Botanical Description:

Mentha piperita L. is a perennial 50–90 cm high, normally quadrangular and a prototypical member of the mint family. The usually branched stems are often purplish or tinged violet but sometimes they are gray-tomentose.[13] *Peppermint* comes in two varieties: black and white. Black mint features dark reddish-purple stems, petioles, and leaf veins, whereas white mint has light green stems and leaves that lack reddish-purple coloring.

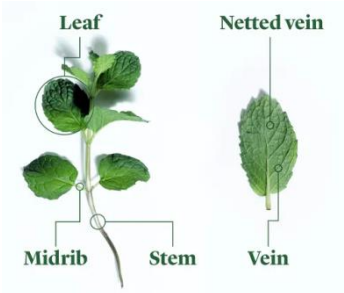

Figure 3 *Peppermint* oil

Figure 4 *Peppermint* Plant

- **Stem:** *Peppermint* has smooth dark green leaves with squared stems and blunt oblong bunches of pink lavender flowers. As with the help of stolon's (underground stems), *peppermint* plants can be produced widely over a large area. Natural hybridization of *peppermint* with different wild species leads to yield a wide range of species of mint. The two most prominent varieties, popularized among the growers are black and white *Peppermint*. *Peppermint* stems are many, branching, and tetrahedron-shaped. They can have a range of colors [14]
- **Rhizome**: The plant's rhizome is horizontal, with a poor root system that extends around 60-80 cm into the earth.
- **Leaf**: The leaves are opposite, short-stemmed, and ovate-oblong or lanceolate in form. They are dark green with small hairs on the underside near the veins.
- **Flower**: Flowers are small and nearly sterile, with a regular five-toothed calyx and a somewhat irregular red-purple corolla with a white tube.[15]

2.1.5 Phytochemical Profile:

The chemical composition of the essential oil from *Mentha piperita. L,* analyzed using GC/FID and GC-MS, showed that the different constituents were extracted from different parts of plant. [19].

Plant parts	Chemical constituent
Leaves[16]	*Mentha piperita* leaves include of essential oils. It also have terpenic group like monoterpenes and of sesquiterpenes are the most important components of *peppermint* leaves and other classes include aromatic hydrocarbons , lactones , aldehydes , and alcohols.
Roots[17]	Chloroform, hexane, petroleum ether, Limonene, Menthone, Cineole, Menthofuran, Methyl acetate, Isopulegol, pulegone, Menthol, Carvone.
Stem[18]	It contain flavonoids like Narirutin , Hesperidin , Luteolin-7-O-rutinoside and Phenolic content like Rosmarinic acid, Chlorogenic acid, p-Hydroxybenzoic.

2.1.6 Pharmacological Action

Anti-bacterial activity: *Mentha piperita L*. essential oils show significant antibacterial and antifungal activity against gram positive and gram negative bacteria, as well as yeast and fungi, mostly because menthol and menthone are main chemical constituents.[20] The antimicrobial effect of *Mentha piperita* oil against bacteria (gram negative, gram positive), fungus and yeasts in liquid as well as in vapor phase has been studied by employing various antimicrobial assays. Morphological alteration in *B. subtilis* due to treatment with *Mentha piperita* oil in different phase has been studied by scanning electron microscope and analyzed by GC, GC–MS [21].

Anti-emetic activity: *Peppermint* oil and its main constituent (-)-menthol inhibit the cationic influx through 5- HT 3 receptor channels in a concentration-dependent manner. (-)-Menthol is responsible for rather half of the effect of the volatile oil. [22]

Anti-oxidant activity: The essential oil and chloroform extract demonstrated the highest antioxidant capacity, followed by ethyl acetate and ethanol extracts. *Peppermint* oil and its extracts were found to possess significant antioxidant properties, making them potential candidates for use in food preservation and as natural antioxidants in various industries. [23]

Immunomodulatary effect : *peppermint* oil and its components (such as menthol, menthone, and 1,8-cineole) demonstrated significant anti-allergic properties. These were observed through the inhibition of histamine release and the suppression of smooth muscle contraction in allergic reactions. Also the effects of *peppermint* oil were compared to other natural resins like chicle and jelutong, as well as to established anti-allergic drugs like ketotifen and tranilast. *Peppermint* oil's efficacy was notable, although the drugs generally showed stronger effects. [24]

Skin and mucus membranes: *Peppermint* oil show Analgesic and coolant effect by stimulating cold receptors on the skin and dilates blood vessels, causing a sensation of coldness and an analgesic effect. Menthol moderates oral sensations of warmth and coldness. In low concentrations, topical application of menthol causes a cooling sensation, while in high concentrations it causes irritation and local anesthesia. [25]

Effect on headache: *Peppermint* and its derivatives are the most effective treatments for headaches [186]. It is demonstrated some benefit from *peppermint* and eucalyptus oil in conjunction to alleviate patients' headache pain. [26]

Effect on GI tract: *Menthae Piperitae* (*peppermint* oil) has several beneficial effects on the digestive system like Reduces intracolonic pressure, Relaxes the esophageal sphincter, which may allow reflux to occur, Acts as a spasmolytic agent, reducing smooth muscle contraction in the GI tract, making it effective in managing Irritable Bowel Syndrome (IBS), Has anti-inflammatory properties, which may modulate cytokine inflammatory pathways, Has anti-microbial properties, which may positively impact the gut micro biome and intestinal motility. Overall, *peppermint* oil has natural carminative, antispasmodic, and anti-inflammatory properties that may provide relief for digestive issues like IBS. [27, 28]

2.2 *Prnus dulcis*

2.2.1 Taxonomical Classification [29]

Order	Rosales
Family	Rosaceae
Sub-family	Prunoidea
Genus	Prunus
Sub-genus	Amygdalus
Species	*Prnus dulcis*
Local name	Badaam

2.2.2 Vernacular Names of *Prnus Dulcis* [30,31]

- **Sanskrit**: Vatadha, Badam
- **Hindi**: Badaam
- **Gujarati**: Badamalili
- **English**: sweet almond

2.2.3 Geographical Distribution

Almonds are mostly farmed in India's Kashmir area and are considered a major crop. The plant is widely grown in Western and Central Asia, Europe, and Eastern Asia, Turkey, Egypt, United States (81%), Spain (9%), and Australia Chain, India, and Iran account for three percent. In India, almond is cultivated in Punjab, Kashmir and Himachal Pradesh. Almonds are also widely cultivated in several of Hilly parts of Uttar Pradesh; however the fruiting has not Very hopeful due to strong rainfall. It is widely grown in warmer parts of the world, such as California, Persian, India, Kashmir, Spain, and Italy, Morocco [32, 33]. The almond is the earliest deciduous fruit and nut tree to bloom in spring due to its low winter chilling requirements and quick growth response to warm temperatures [34].

Figure 5 Almond Oil

2.2.4 Botanical Descriptions

This medium-sized, multi-stemmed deciduous tree has fissured stems, green, lustrous, linear to oval, toothed margin, and petiolated leaves. It produces white to light pink flowers with five petals, either alone or in clusters. The fruit is drupe, with a hard outer shell, brown seed, nut or stone, ridges on the surface, one seed of a fruit is edible. Flowering and fruiting season is from March to April. Parts used are leaves and seeds (badam kernels). Cultivation is done in wild. [35]

Tree: The tree has brown or grey bark and grows erect or weeping, depending on the type. The trunk can be 30 cm (12 in) in diameter. Almond leaves are 7.5-13 cm (3-5 in) long, serrated, and grow alternately on the branches. The tree bears oblong, hairy green fruits and white to pale pink blooms. The fruit is a drupe with a single seed. The seed is surrounded by a hard brown shell. [36]

Flower: From late January to early April north of the Equator, blooms produce fragrant, five-petaled blossoms ranging from light pink to white. The blooms are self-incompatible, so insect pollinators are required to promote cross-pollination with other cultivars. The developing fruit (a drupe) resembles a peach until it reaches maturity; as it ripens, the leathery outer covering, or hull, breaks open, folds outward, and releases the pit. [37]

Fruit: The almond fruit is 3.5–6 cm (1+3⁄8–2+3⁄8 in) long. It is not a nut but a drupe. The outer covering, consisting of an outer exocarp, or skin, and mesocarp, or flesh, fleshy in other members of *Prunus* such as the plum and cherry, is instead a thick, leathery, gray-green coat (with a downy exterior), called the hull. Inside the hull is a woody endocarp which forms a reticulated, hard shell (like the outside of a peach pit) called the pyrena. Inside the shell is the edible seed, commonly called a nut. [38]

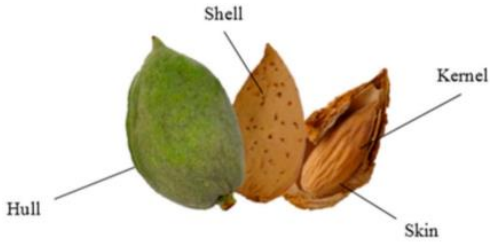

Figure 6 Parts of Almond Fruit

2.2.5 Phytochemical profile

The nutritional and commercial value of almonds is limited to the kernel. By-products such as hull, shell, and skin are underexplored and require more information on their physicochemical properties, composition, and extraction procedures for sustainable and competitive exploitation.
The bioactive compounds in almond by-products can be categorized into phenolic compounds and terpenoids.

Phenolic compounds are further divided into non-flavonoids (phenolic acids) and flavonoids. The non-flavonoids include benzoic acids such as p-hydroxybenzoic acid, vanillic acid etc. Flavonoids include Flavonols, Flavanones, Procyanidins.

Terpenoids are divided into sterols and triterpenoids. The sterols include stigmasterol and β-sitosterol. The triterpenoids include betulinic acid, ursolic acid etc. [39]

Plant parts	**Chemical constituent**
Almond Skin[40]	Almond skins can be considered functional food ingredients because they contain several bioactive phenolic compounds, namely flavonoids, phenolic acids, and tannins; they are also rich source of fiber.
Almond Shell[41]	Almond shells include C (72.27%), O (22.88%), N (3.87%), and Si (0.87%). The main chemical constituents of cellulose, hemicellulose and lignin.
Almond Hull[42]	Almond hull consist of protein Detergent fiber along with crude lignin depending on the harvest process, ashes can vary.

2.2.6 Pharmacological Action

Emollient and moisturizing: Almond oil contains Vitamin A, Vitamin E, and Zinc. **Vitamin A**: regulates cell maturation, promoting smooth skin and healthy collagen, reducing fine lines and wrinkles, **Vitamin E**: antioxidant properties minimize UV-induced cell damage, delaying photo aging, **Zinc**: anti-inflammatory and astringent properties reduce inflammation in skin conditions, promoting healthier skin. These nutrients combined help achieve a smoother, more youthful appearance and protect against skin damage [43]

Anti-Inflammatory: Inflammation is a process in the body that can be measured by certain markers like E-selectin, CRP (C-reactive protein), IL-6 (interleukin-6).
High levels of these markers are associated with an increased risk of cardiovascular disease (CHD). Even small changes in CRP levels within the normal range can predict vascular events in healthy individuals. Thus consuming almonds as part of a heart-healthy diet has been shown to decrease serum E-selectin and CRP, indicating a reduction in inflammation. [44]

Anti-oxidant: Almond skin shows anti-oxidation action by Inhibits formation of ROS (reactive oxygen species). It acts by Activates Nrf2 antioxidant pathway which Restores activity of endogenous antioxidant enzymes (superoxide dismutase, catalase, and glutathione) and Reduces lipid peroxidation. [45]

Laxative: The laxative effect is partly inhibited by atropine, indicating involvement of muscarinic receptors. The mechanism of action suggests the presence of an Acetylcholine (ACh)-like component. ACh is the main excitatory neurotransmitter in the enteric nervous system, activating muscarinic receptors to stimulate gastric function. The ACh-like action of almond oil may increase its potential use in medicine for treating constipation and other gastrointestinal disorders. [46]

Cardio protective action: The cardio protective action of almonds acts by improving certain cardiovascular disease (CVD) risk factors, particularly Lowering LDL cholesterol (LDL-C). It also Alter gut micro biome composition [47].

Antimicrobial: The Polyphenols from natural almond skin (NS MIX) exhibit Antimicrobial activity against Staphylococcus aureus (including MRSA) with MIC values of 0.31-1.25 mg/ml. Specific polyphenol compounds, epicatechin and catechin, showed high activity against S. aureus ATCC 6538P but not against all strains.[48]

Hepatoprotective: A preclinical study found that animals given almond oil before exposure to a toxic substance (CCl4) shows Lower liver damage markers (ALT, AST, ALP, LDH), Lower cholesterol and triglycerides, Higher good cholesterol (HDL), Increased antioxidant enzymes (SOD, catalase, GPx), Decreased oxidative stress marker (MDA).[49]

Ulcer protective: Sweet almonds, specifically almond purée, milk, and oil, have been found to have anti-ulcer properties, reducing hydrochloric acid concentration and peptic activity in the stomach. By the action of forming a protective film formed by almond protein and oil on the mucosa, Buffering of hydrochloric acid by almond protein, Hormonal regulation of gastric secretion and motility by almond oil.[50]

Conclusion:

This comprehensive review highlights the potential of *peppermint* (*Mentha piperita* L.) and raw almonds (*Prunus dulcis*) in managing acidity and promoting gastrointestinal health. *Peppermint*, with its rich phytochemical composition, including menthol and menthone, exhibits significant anti-inflammatory, antispasmodic, and antimicrobial properties that contribute to its ability to alleviate gastrointestinal discomfort, reduce acidity, and manage symptoms associated with GERD. Raw almonds, known for their high content of bioactive compounds like flavonoids and phenolic acids, demonstrate acid-neutralizing properties and contribute to the reduction of oxidative stress in the gastrointestinal tract. Both natural remedies offer promising therapeutic benefits as acidity suppressors, although further clinical studies are needed to validate these effects and determine the optimal dosages for effective treatment. The integration of *peppermint* and raw almonds into dietary and therapeutic regimens could offer a natural, complementary approach to managing gastrointestinal disorders, particularly acidity-related conditions.

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