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Research Article

Formulation and Evaluation of Polyherbal Tea for Gut Health

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Abstract

Gut health refers to the proper functioning and balance of the gastrointestinal (GI) tract, including organs such as the stomach, intestines, and colon. A healthy gastrointestinal system plays an essential role in the digestion and absorption of nutrients, the elimination of metabolic waste, and the regulation of immune responses. It also maintains a balanced population of beneficial microorganisms collectively known as the gut microbiota. These microorganisms contribute to various physiological functions, including the synthesis of essential vitamins, protection against pathogenic microbes, and interaction with other body systems. Maintaining optimal gut health is important not only for efficient digestion but also for overall physical and mental well-being. However, modern dietary habits, stress, sedentary lifestyles, and excessive antibiotic use may disrupt the gut microbiome, leading to digestive disorders such as bloating, indigestion, and constipation, as well as reduced immunity. This study focuses on the formulation and evaluation of a polyherbal tea designed to support gut health and alleviate digestive discomfort. Ingredients such as fennel (*Foeniculum vulgare),* amla or Indian gooseberry (*Emblica officinalis*), ginger (*Zingiber officinale*) and fenugreek (*Trigonella foenum-graecum*) are incorporated. These selected ingredients are known for their anti-inflammatory, carminative, and prebiotic properties. The optimised blend exhibits favourable organoleptic quality, high total phenolic content and effective free radical-scavenging activity. Overall, the polyherbal tea presents a viable, palatable functional beverage for mitigating digestive discomfort and support gut health.

Keywords: Gut–brain axis, Amla, Ginger, Fenugreek, Antioxidant, Carminative, Prebiotics, Probiotics.

INTRODUCTION

Gut health refers to the proper functioning and balance of the gastrointestinal (GI) tract, which includes organs such as the stomach, intestines, and colon. A healthy digestive system effectively breaks down food, absorbs nutrients, removes waste products, and plays an important role in supporting the body's immune system. It also maintains a balanced population of beneficial microorganisms known as the gut microbiota. These microorganisms contribute to the production of certain vitamins, help to defend the body against harmful pathogens, and interact with other body systems. One of the most significant interactions occurs through the gut–brain axis, which connects the digestive system with the brain and influences both physical and mental health. Therefore, maintaining good gut health is essential not only for proper digestion but also for overall well-being. When gut health is disrupted, it may result in problems such as bloating, constipation, food intolerances, weakened immunity, and mental health conditions like anxiety and depression. Healthy lifestyle practices such as consuming fibre-rich foods that act as prebiotics, including probiotics in the diet, staying well hydrated, engaging in regular physical activity, managing stress, and avoiding unnecessary antibiotic use can help maintain a healthy gut[1].

Probiotics and prebiotics are microbiota-management tools for improving gut health[2]. Probiotics are live, beneficial bacteria that can improve or restore the gut microbiota. They help to balance the gut flora, enhance digestion, strengthen the immune system, and may reduce symptoms of digestive disorders such as irritable bowel syndrome (IBS) and diarrhoea. Prebiotics, conversely, are non-digestible food components (fibers) that serve as food for probiotics, stimulating their growth and activity. They help to support a healthy gut environment by promoting the proliferation of beneficial bacteria. Together, probiotics and prebiotics contribute to better gut health by enhancing microbial balance, improving nutrient absorption, modulating the immune response, and reducing gut inflammation[3-5].

In recent years, nutraceuticals derived from natural sources have gained attention for their potential to promote digestive health and prevent gastrointestinal disorders. Nutraceuticals support gastrointestinal tract (GIT) health by promoting gut microbiota balance, strengthening the intestinal barrier, reducing

inflammation, and aiding in digestion. Some target issues include IBS, IBD, leaky gut, and dysbiosis[6,7].

Nutraceuticals are bioactive compounds derived from food sources that provide health benefits beyond basic nutrition, often bridging the gap between nutrition and pharmaceutical effects. They are available as dietary supplements, functional foods, or fortified products and are regulated as foods rather than drugs[6].

The term "nutraceutical", coined by Stephen DeFelice in 1989, merges "nutrient" and "pharmaceutical" to describe products like plant extracts or compounds with therapeutic potential for disease prevention or management. Unlike pharmaceuticals, which target specific diseases with synthetic ingredients, nutraceuticals focus on overall wellness[7].

In 2026, the nutraceutical industry has evolved from general supplementation to "precision nutrition", utilizing AI and genetic data to tailor nutrients for specific goals like "brainergy" (mental energy and focus) and metabolic resilience. By bridging the gap between the grocery store and the pharmacy, nutraceuticals empower individuals to manage chronic conditions. The nutraceutical market in 2026 continues its robust expansion as a key pillar of preventive healthcare. Estimates place the global size at USD 547-685 billion this year, reflecting strong consumer demand for functional foods and supplements.

Table 1: Types of Nutraceuticals[8]

Segment	Sub-segments
Functional Foods	Everyday foods with health-boosting properties – fortified cereals, probiotic dairy products, functional snacks, fortified oils
Functional Beverages	Energy drinks, sports drinks, fortified juices, probiotic beverages
Dietary Supplements	Vitamins, minerals, herbal supplements, probiotics, and omega-3
Medicinal Foods	Formulated foods for specific medical conditions (Protein shakes for diabetics, electrolyte-rich drinks).
Plant-Based Nutraceuticals	Contain bioactive compounds derived from plants (Curcumin, resveratrol, and quercetin)

Nutraceuticals play an important role in managing chronic diseases by targeting underlying mechanisms like inflammation, oxidative stress, and metabolic dysfunction, often as complementary therapies with fewer side effects than conventional drugs[9].

Foeniculum vulgare (commonly called fennel) is a hardy, aromatic, perennial or short-lived herbaceous plant, belonging to the family Umbelliferae, widely cultivated around the world. It is used as a traditional medicine and as both a vegetable and as a spice-type herb[10]. It provides several digestive benefits, like carminative, antispasmodic, and gastroprotective actions. Fennel fruit contains essential oils rich in anethole, fenchone, and estragole, which help to relax the smooth muscles of the gastrointestinal tract, thereby reducing intestinal spasms, bloating, gas, and cramping commonly seen in conditions such as indigestion, flatulence, and irritable bowel syndrome. It also promotes the secretion of digestive enzymes and bile, which supports efficient digestion and can relieve symptoms like heartburn, stomach ache, and colic in infants. In addition, the dietary fiber in fennel fruits adds bulk to the stool and supports regular bowel movements, helping to prevent constipation, while experimental studies suggest that fennel and its extracts may exert anti-inflammatory and antioxidant effects on the gut lining, offering protection against gastric ulcers and some forms of inflammatory bowel conditions[11-14].

Emblica officinalis, known as Amla or Indian gooseberry is a well-known dietary supplement in Ayurveda used for iron deficiency, belonging to the Euphorbiaceae family. It is often called the "king of medicinal plants" due to the exceptional nutritional profile of its fruits, which contain 20-30 times more vitamin C than oranges, along with polyphenols like emblicanins, gallic acid, ellagic acid, quercetin, tannins, and flavonoids[15-16]. In traditional Indian medicine, all parts of the amla tree like the fruits, seeds, leaves, bark, and roots are utilised to treat ailments such as diarrhoea, jaundice, inflammation, headaches, digestive issues, and fever, liver tonic, diuretic, and immunomodulator. It forms an important ingredient in formulations like Triphala and is valued for enhancing immunity, memory, hair growth, and wound healing. Modern studies support its antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, cardioprotective, and lipid-lowering effects, with clinical trials showing reductions in LDL cholesterol and benefits for cardiovascular risk factors[15-17]. The fruit's rich bioactive compounds, including terpenoids, alkaloids, and pectin, contribute to its broad therapeutic potential against oxidative stress, tumours, ulcers, and neurodegenerative diseases. While generally safe, its potent antioxidants may interact with

chemotherapy or radiation, warranting caution in clinical settings[17,18].

Zingiber officinale known as Ginger belongs to the family Zingiberaceae. It is a powerful botanical ingredient valued for its rich bioactive compounds, primarily gingerols, and zingerone. It is native to tropical and subtropical regions, mainly in south and southeast Asia. Plants in the family produce fleshy, aromatic underground rhizomes that store nutrients and essential oils. It exhibits strong anti-inflammatory, antioxidants and gastroprotective properties. Commonly formulated in herbal remedies, ginger helps to regulate inflammatory signaling pathways, soothing gastrointestinal discomfort, alleviating nausea and protecting the stomach lining. Ginger plays a key role in managing gastroesophageal reflux disease (GERD) and general indigestion through multiple mechanism such as prokinetic effect, gastric mucosal shield, lower oesophageal sphincter. Additionally, ginger exhibits anti-inflammatory and antioxidant activities through the modulation of inflammatory cytokines, regulation of inflammation-associated enzymes, and scavenging of free radicals, thereby potentially supporting gastrointestinal health and protecting intestinal tissues against oxidative stress[19].

Fenugreek consists of the dried ripe seeds of *Trigonella foenum-graecum L.,* belonging to the family Fabaceae (Leguminosae). It is widely cultivated in India, North Africa, the Mediterranean region, Southern Europe, and North America. Fenugreek seeds contain several biologically active constituents, including steroidal saponins such as diosgenin, gitogenin, and yamogenin, which are used as precursors for steroid synthesis; alkaloids such as trigonelline and choline; and the amino acid derivative 4-hydroxyisoleucine, which is associated with insulin-stimulating activity. They also contain soluble fibre, primarily galactomannan mucilage, which may constitute up to 30% of the seed weight. Fenugreek is traditionally used as an aromatic and bitter tonic, appetite stimulant, and carminative in digestive formulations. Its alkaloids and volatile constituents contribute to its characteristic properties. Additionally, flavonoids such as vitexin and quercetin exhibit antioxidant and anti-inflammatory activities by scavenging free radicals and potentially modulating inflammatory pathways, including cyclooxygenase-2 (COX-2)[20].

MATERIAL AND METHODS

I. Plant Material Collection and Authentication

Herbal ingredients mentioned in the formula were procured from the local market and were authenticated by the botanist at Central Ayurveda Research Institute, Bengaluru. The voucher specimen (RRCBImus 145/205/19461) was preserved for future reference.

II. Preparation of Polyherbal tea

Herbal ingredients mentioned in the formula (Table 2) Ingredients such as fenugreek seeds (*Trigonella foenum-graecum*), fennel (*Foeniculum vulgare*), amla (*Phyllanthus emblica*), and fresh ginger rhizomes (*Zingiber officinale*) were collected. Fennel and fenugreek were washed thoroughly under running potable water to eliminate surface dust and extraneous residues. The fresh ginger and amla were peeled and sliced into thin, uniform pieces to facilitate uniform drying. The cleaned ingredients were spread out in a single, thin layer on clean stainless-steel trays. They were subjected to indirect sun drying for several days until completely moisture-free, ensuring the prevention of microbial growth and spoilage during storage. Dried ingredients (fenugreek, fennel, amla, and ginger) were transferred to a mechanical grinder. The ingredients were ground separately into a coarse powder. The powdered mixture was then passed through a standard mesh sieve to ensure a uniform particle size, which optimises the extraction rate during brewing. The individual powders of fenugreek, fennel, amla, and ginger were mixed in specific proportions to create a uniform herbal tea blend. A measured quantity of the blended herbal powder was accurately filled into food-grade, heat-sealable filter paper tea bags. The tea bags were securely sealed to prevent moisture absorption and stored in airtight, moisture-proof containers in a cool, dry place until further use or analysis[21].

Table 2: Formula for preparing a Polyherbal Tea

Sl. No.	Ingredients	Quantity taken (for 5gms)
1.	Fenugreek powder	0.5g
2.	Amla powder	1.5g
3.	Fennel powder	2g
4.	Ginger powder	1g
	TOTAL	5gms

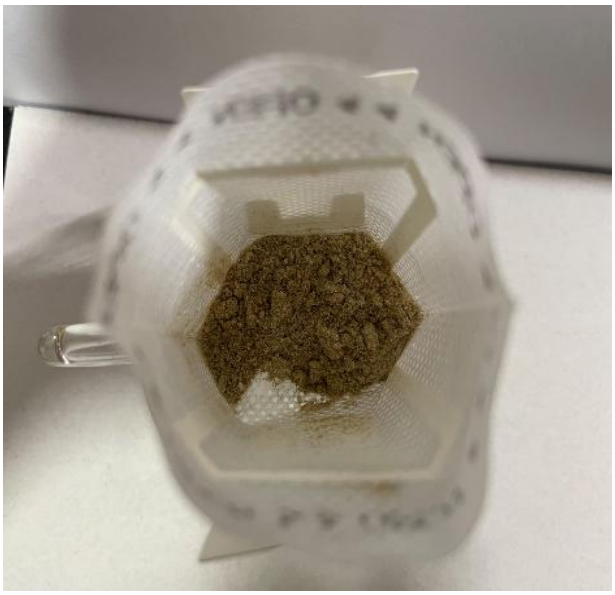


Figure 1: Polyherbal Tea powder

III. Determination of Organoleptic Evaluation

The color, and odor of powder were evaluated using the sensory organs of our body, and the results are summarized in Table 3.

IV. Determination of Physicochemical Parameters[22]

1. Determination of pH value:

1 gm of the formulated polyherbal tea was weighed and added to 100 ml of distilled water in a beaker. It was stirred well and left to stand for 30 minutes. This solution was filtered using a muslin cloth to get a clear extract. Using a pH meter (Eutech pH-Meter Model – OAKTON-4, S/N 2492141) calibrated with standard buffer solutions (pH 4, 7, 9). Then dipped the pH meter into the filtered powder extract. The reading was stabilized, and pH was recorded.

2. Determination of ash value: Used to determine the quality and purity of a crude drug.

Total ash: Approximately 2 gm of formulated polyherbal tea was accurately weighed into a tarred silica crucible and placed in a muffle furnace at a temperature not exceeding 450°C until it was free from carbon. Then it was cooled and weighed. The percentage of total ash was calculated with reference to the air-dried drug.

% Total Ash value = [Weight of total ash / air-dried drug] × 100

Acid-insoluble ash: The total ash obtained was boiled for 5 minutes with 25 ml of dilute hydrochloric acid; the insoluble matter obtained was collected on an ashless filter paper, washed with hot water until the filtrate was neutral, and ignited to constant weight. The percentage of acid-insoluble ash was calculated with reference to the air-dried drug.

% Acid insoluble ash value = [Weight of acid insoluble ash / air dried drug] × 100

Water-soluble ash: The ash obtained in the determination of total ash was boiled for 5 minutes with 25 ml of water. The insoluble matter was collected on an ashless filter paper and washed with hot water. The insoluble ash was transferred into a tarred silica crucible and ignited for 15 minutes at a temperature not exceeding 450°C. The weight of the insoluble matter was subtracted from the weight of the total ash. The difference in weight was considered as the water-soluble ash was calculated with reference to the air-dried drug.

% Water-soluble ash value = [Weight of water-soluble ash / air-dried drug] × 100

3. **Moisture content (Loss on drying):** Formulated polyherbal tea was weighed and placed in a tarred flat-bottomed shallow dish. It was warmed for half an hour in a hot air oven which was adjusted to 105-110°C. The amount of moisture present in the crude drug was calculated using the standard formula.

% Loss on drying = [Initial weight - final weight / initial weight] × 100

V. Determination of Phytochemical Evaluation[23]

To prepare the sample solution of polyherbal tea, it was extracted with chloroform-water. After extraction, it was filtered, and the filtrates were used for the following tests.

1. Detection of Alkaloids

Mayer's Test: a little quantity of filtrate was dissolved with a few droplets of Mayer's reagent (HgI_4K_2). A yellow to off-white color precipitate developed, indicating the presence of alkaloids.

Wagner's Test: A small quantity of filtrate was dissolved with a few drops of Wagner's reagent (Iodo-potassium iodide) and observed. A reddish-brown or brown precipitate developed, indicating the presence of alkaloids.

Dragendroff's Test: Little quantity of filtrate was dissolved with Dragendroff's reagent ($K[BiI_4]$ solution). A red-colored precipitate developed, indicating the presence of alkaloids.

Hager's Test: A little quantity of filtrate was dissolved with Hager's reagent (saturated picric acid solution). A yellow precipitate developed, indicating the presence of alkaloids.

2. Detection of Glycosides

Modified Borntrager's test (Anthraquinone Glycoside): A little quantity of filtrate was prepared with $FeCl_3$ solution. Then it was warmed on a water bath for a few minutes, cooled, and shaken with the same amount of benzene. The layer of benzene was discarded and treated with an NH_3 solution. The development of a cherry red or pink color in the ammonical layer indicated the presence of anthraquinone glycosides.

Legal's Test (Cardiac Glycoside): Treated the test extract with pyridine and methanolic alkali and added sodium nitroprusside. A pink-to-red color is produced, which indicated cardiac glycosides.

Baljet Test (Cardiac Glycoside): Treated the test filtrate with sodium picrate. A deep orange-yellow color confirmed cardiac glycosides.

Liebermann-Burchard's Test (Cardiac Glycoside): To the extract, chloroform was added and filtered. Drops of acetic anhydride and concentrated H_2SO_4 were added to the filtrates through the walls of the test tube. A deep brown or pink-colored ring developed at the junction of two layers, which confirmed cardiac glycosides.

Froth Test (Saponins Glycoside): To the extracts (alcoholic and aqueous), distilled water was added and shaken for a few minutes in a measuring cylinder. 1 cm of foam developed, which indicated saponins.

Liebermann-Burchard's Test (Steroidal and triterpenoid glycosides): To the extract, chloroform was added and filtered. Drops of acetic anhydride and concentrated H_2SO_4 were added to the filtrates through the walls of the test tube. A deep brown-colored ring developed at the junction of two layers. The top layer

turned green, which confirmed steroidal or triterpenoid glycosides.

3. Detection of Phenolic compounds and Tannins

Ferric Chloride Test: Added ferric chloride solution (5%) to the filtrate. A blue-black color is produced, which confirmed the presence of a phenolic nucleus.

Gelatin Test (Tannin Test): Filtrate was treated with gelatin solution (1%) containing NaCl. A white precipitate developed, which confirmed the presence of tannins.

Lead Acetate Test (Flavonoid Test): The filtrates were treated with a 10% lead acetate solution. A yellow precipitate developed, which confirmed the presence of flavonoids.

Alkaline Reagent Test (Flavonoid Test): The filtrates were treated with NaOH. A yellow color developed that turned colourless on adding drops of dilute acid, indicating the presence of flavonoids.

Shinoda Test (Flavonoid Test): To the filtrates, a few fragments of Mg metal were added, followed by the addition of concentrated HCl. Magenta color developed, which indicated the presence of flavonoid.

Vanillin Hydrochloric Test (Tannin Test): The filtrates were treated with drops of vanillin hydrochloride reagent. A pink-red color developed, which confirmed the presence of tannins.

4. Detection of Proteins and Amino acids

Millon's Test: The filtrates were treated with Millon's reagent. A white precipitate developed, which turned red on heating; this indicated the presence of proteins and amino acids.

Biuret Test: The filtrates were treated with a 10% NaOH solution and warmed. To it, it added a 0.7% $CuSO_4$ solution. Violet color developed, which indicated the presence of proteins.

Ninhydrin Test: The filtrates were treated with ninhydrin reagent and boiled. Blue color developed, which indicated the presence of amino acids.

5. Detection of Fixed oils and Fats

Stain Test: The filtrate was sandwiched between two filter papers. An oily stain on filter paper indicated the presence of fixed oil.

Soap Test: The filtrates were heated with a 0.5 N alcoholic KOH solution. Soapy formation occurred, which indicated the presence of fixed oils and fats.

6. Detection of Carbohydrates

Molisch's Test: To the filtrates, added alcoholic α-naphthol solution and concentrated H_2SO_4. A violet ring appeared at the junction, which confirmed the presence of carbohydrates.

Benedict's test (Reducing sugar test): To the filtrates, added Benedict's reagent. The mixture was heated on a water bath. A precipitate developed, which was orange red, indicating the presence of reducing sugars.

Fehling's Test (Reducing Sugar Test): To the filtrates, dilute HCl was added for hydrolysis and heated. Equal volumes of Fehling's A and B solutions were added. A precipitate developed, which was a deep red colour, indicating the presence of carbohydrates.

Barfoed's Test (Monosaccharide): The filtrates were treated with Barfoed's reagent. The mixture was heated on a water bath. A precipitate developed, which was orange-red, indicating the presence of reducing sugars.

7. Detection of Gums and Mucilage

Alcohol Precipitate Test: The filtrates were treated with absolute alcohol and stirred. The precipitate developed, which was filtered and air-dried. It was then observed for swelling properties.

Molisch's Test: To the above precipitate, alcoholic α-naphthol solution and concentrated H_2SO_4 were added. The appearance of a violet ring at the junction indicates the presence of carbohydrates.

Ruthenium Red Test: The above precipitate was mounted on a slide, and ruthenium red solution was added and observed under a microscope. A red-pink color developed, which indicates the presence of gums and mucilage.

VI. Determination of Microbial content[24,25]

1 gm of formulated polyherbal tea was dissolved in lactose broth, and the volume was adjusted to 100 ml with the same medium. About 10 ml of the sample was transferred into 100 ml of MacConkey broth and incubated for 18-24 hours at 43-45°C. A subculture was prepared on a plate with MacConkey agar and incubated at 43-45°C for 18-24 hours. The growth of red, generally non-mucoid colonies of gram-negative rods appearing as reddish zones indicates the presence of *Escherichia coli* if not, then it indicates the absence of *Escherichia coli*.

VII. Analysis of Essential Mineral Nutrients[26]

The formulated polyherbal tea was dried in the oven at 60°C to constant weight, following the procedure as described by Piper (1966), ground in a porcelain mortar and pestle, and stored in airtight containers. The concentration of phosphorus in powder samples was determined by the molybdovanadate method, and potassium was determined by flame photometer. The concentration of micronutrients was determined using an Atomic Absorption Spectrophotometer (AAS 280 FS Agilent Technologies, Santa Clara, USA) by the wet digest method with HNO_3 and $HClO_4$ in a 10:4 ratio.

VIII. Determination of DPPH[27]

DPPH radical scavenging ability is determined mostly in organic solvents such as methanol or ethanol by measuring the absorbance drop at 517 nm. The use of methanol is not preferred because of its toxic properties. Analyses were performed with a UV-vis spectrophotometer in 1 mL or 3 mL cuvettes. For this purpose, a stock solution of 10^{-3} M DPPH radicals in ethanol or methanol was freshly prepared before analysis. To prepare the DPPH solution, 3 mL of the

stock solution was diluted to 50 mL with methanol in a volumetric flask and protected from light with aluminum foil. Absorbance values were set to 1.00 ± 0.200. Then, 3 mL of DPPH working solution was transferred to the 0.5 mL extract, mixed, and left in the dark for 30 min. The purple colour disappears when an antioxidant agent is present in the reaction medium. A reference sample containing 0.5 mL of solvent was similarly prepared. A newly prepared DPPH radical solution shows maximal absorption at 517 nm. All analyses were carried out in 3 replicates, and absorbance was recorded at 517 nm. The blank is the reaction mixture that does not contain test compounds.

$$\text{RSA (\%)} = [\ (Ac - As)/Ac] \times 100$$

The radical scavenging activity (RSA) of extracts was calculated using the above equation, where A_c is the absorbance at 517 nm of the control sample, and A_s is the absorbance at 517 nm that contains the test sample (tea extracts). The IC_{50} was calculated from the graph plotting scavenging percentage against test sample concentration (µg/mL).

RESULT AND DISCUSSION

Organoleptic Evaluation

The organoleptic evaluation of the formulated polyherbal tea confirmed acceptable sensory characteristics, including color, taste, texture, odor, and appearance, ensuring consumer palatability and compliance, as shown in Table 3.

Table 3: Parameters in Organoleptic Evaluation

Sl. No.	Organoleptic studies	Description
1.	Colour	Greenish
2.	Odor	Aromatic
3.	Taste	Slightly bitter
4.	Texture	Coarse powder

Physicochemical Parameters

Physicochemical evaluation showed desirable values for moisture content, ash value, and pH, indicating polyherbal tea stability, purity, and shelf-life compatibility.

Table 5: Physicochemical parameters

Sl. No.	Physicochemical studies	Parameters
1	pH	5.5 - 6.5 (ideal)
2	Ash value in %	
	Total Ash value	7.50%
	Acid-insoluble ash value	1.20%
	Water-soluble ash value	4.00%
3	% Loss on drying	67%

Phytochemical Evaluation

To prepare the sample solution of polyherbal tea, it was extracted with chloroform-water. After extraction, it was filtered, and the filtrates were used for the following tests.

Table 6: Phytochemical parameters

Sl. No.	Phytochemical tests	Description
1	Alkaloids	+
2	Glycosides	+
3	Phenolic compounds and Tannins	+
4	Proteins and amino acids	-
5	Fixed oils and Fats	+
6	Carbohydrates	+
7	Gums and Mucilage	+

Microbial content

The formulated polyherbal tea was finally subjected to microbiological evaluation, for *Escherichia coli* and was found to be absent; hence, the formulated polyherbal tea complied with the WHO requirements.

Table 7: Detection of microbes in formulated polyherbal tea

Sl. No.	Microorganism	Present/Absent
1	*Escherichia coli*	Absent

Analysis of Essential Mineral Nutrients The analysis of essential mineral nutrients confirmed that the polyherbal tea contains essential macro- and micronutrients like phosphorus (P), Potassium (K), calcium (Ca), magnesium (Mg), manganese (Mn), iron (Fe), and zinc (Zn) which play important roles in maintaining gut health and normal gastrointestinal function. Phosphorus supports cellular energy production and the maintenance of intestinal cells, while potassium helps maintain fluid and electrolyte balance and supports smooth muscle contractions necessary for normal intestinal motility. Calcium contributes to the regulation of intestinal muscle contraction, cellular signalling, and the maintenance of intestinal barrier function. Magnesium supports normal muscle and nerve function and may help promote regular bowel movements. Manganese acts as a cofactor for various enzymes involved in metabolism and antioxidant defence, helping protect intestinal cells against oxidative stress. Iron is essential for oxygen transport, cellular energy metabolism, and the normal functioning of intestinal tissues; however, excessive unabsorbed iron may adversely affect the gut microbiota. Zinc is particularly important for maintaining intestinal

mucosal integrity, supporting epithelial cell growth and repair, regulating immune function, and promoting wound healing. Together, these minerals contribute to normal digestion, intestinal motility, epithelial barrier integrity, and gastrointestinal health when consumed in appropriate amounts.

Table 8: Analytical results of essential mineral nutrients in formulated polyherbal tea (PT).

Sample code	P	K	Ca	Mg	Mn	Fe	Zn
	(%)				(mg/kg)		
PT- R1	0.24	2.36	1.05	0.87	86.90	56.64	29.39
PT- R2	0.25	2.43	0.93	0.86	85.70	44.94	30.34

Determination of DPPH

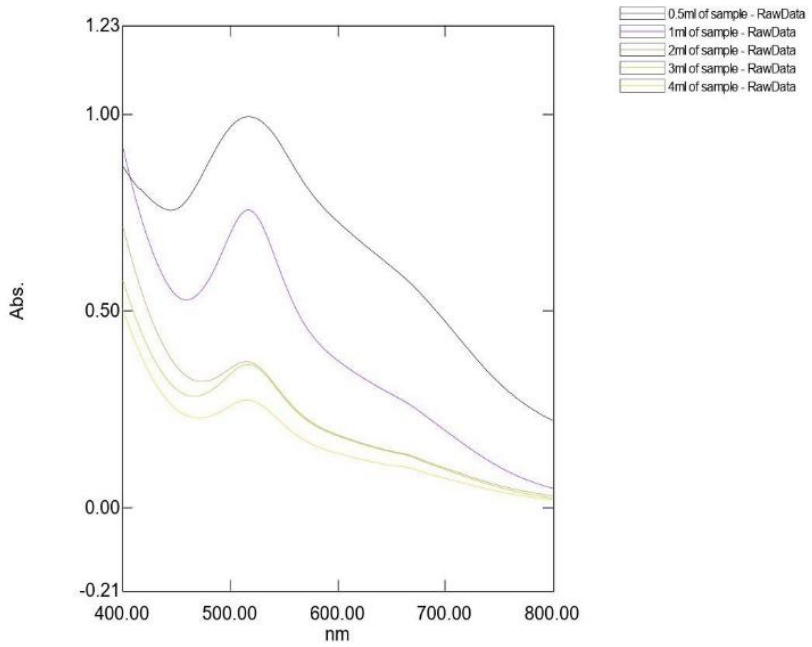


Figure 2: Graphical representation

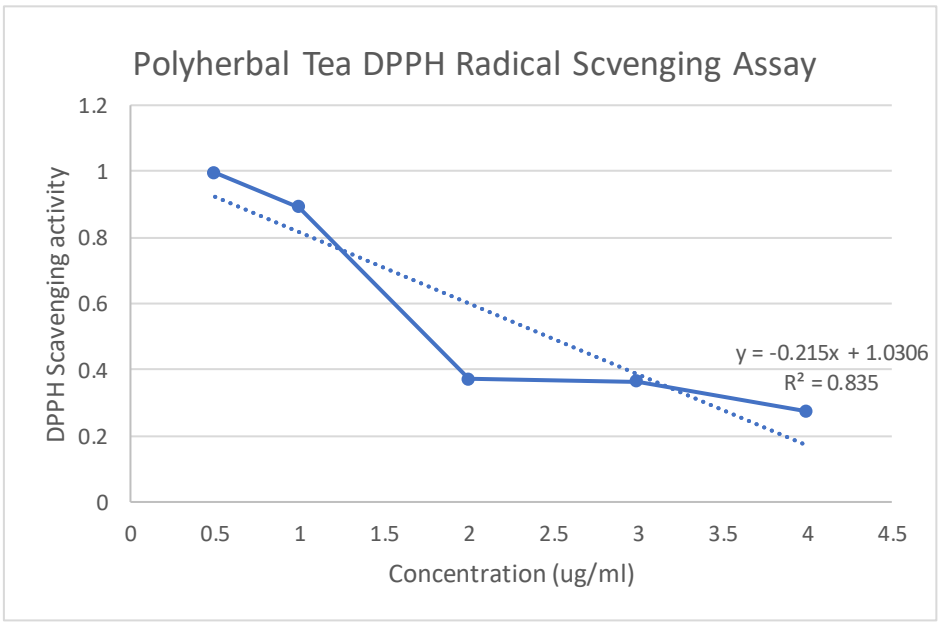


Figure 3: Determination of DPPH

IC_{50} value from this graph is approximately 2.47(µg/mL).



Figure 4: Polyherbal Tea

CONCLUSIONS

The present study successfully formulated and evaluated a polyherbal tea comprising fennel (*Foeniculum vulgare*), amla (*Emblica officinalis*), ginger (*Zingiber officinale*), and fenugreek (*Trigonella foenum-graecum*) in an optimized ratio of 2.0:1.5:1.0:0.5 g, respectively, for its potential role in promoting gut health and alleviating gastrointestinal discomfort. The formulation combines the complementary carminative, antioxidant, anti-inflammatory, and digestive properties of the selected botanicals, highlighting its potential as a functional nutraceutical beverage. Overall, the developed polyherbal tea represents a promising plant-based approach to digestive wellness. However, to validate these findings clinical evaluations are necessary to establish its safety, efficacy, and therapeutic potential on larger human populations.

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