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Phytochemical Analysis and Antioxidant Potential of Various Herbal Green Tea Preparations from Different Indian Medicinal Herbs

Anushka Chaudhary[1], Subir Kumar Bose[2]

[1]Department of Biotechnology and Microbiology, Meerut Institute of Engineering and Technology, NH-58, Baghpatcrossing, Partapurbypass road, Meerut -250005 Uttar Pradesh,India
[2]M.Sc,Biotechnology Scholar, and[#] Associate Professor at Meerut Institute of Engineering and Technology, NH-58, Baghpat crossing, Partapur bypass road, Meerut -250005 Uttar Pradesh, India

ABSTRACT
This research aimed to assess the phytochemical constituents and antioxidant activities of herbal green tea formulations derived from various medicinal plants. These botanical infusions are valued for their therapeutic benefits which stem from bioactive agents likephenols, flavonoids, tannins and alkaloids. Such compounds are essential in mitigating oxidative stress by neutralizing free radicals withinthe body.To isolate the active components; the dried botanical samples underwent methanolic extraction. The resulting extracts were then screened through various qualitative phytochemical analyses to detect specific chemical groups. Furthermore, the antioxidant potential was quantified employing the DPPH (2, 2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. “The findings revealed that the herbal green tea extract possesses robust antioxidant properties primarily driven by its high phenolic content. These results indicate that such herbal infusions could function as a safe natural reservoir of antioxidants potentially playing a role in the prevention of various ailments linked to oxidative stress."

Keywords: - Herbal green tea, phytochemical constituents, antioxidant activities, medicinal plants, DPPH assay and antimicrobial activity

1. Introduction

Since antiquity, humans have turned to medicinal plants as a primary means of curing and preventing various health conditions. Well-established traditional frameworks including Ayurveda, Unani and Chinese medicine rely heavily on botanical solutions, valued for their natural healing power and generally lower risk of adverse reactions compared to synthetic drugs. The efficacy of these plants stems from phytochemicals, which are diverse, biologically active compounds produced by the vegetation. As modern society shifts toward holistic wellness and natural alternatives there has been a notable surge in the popularity of herbal supplements and functional drinks (*Sofowora,* 1993; *Kokate et al.,* 2014).Globally, herbal green tea has emerged as a leading functional beverage, primarily celebrated for its potent antioxidant profile and diverse health benefits. These infusions are formulated by blending various botanical elements—including medicinal leaves, roots, herbs and flowers—each selected for its

specific therapeutic potential. A key distinction lies in its composition; while traditional tea is derived solely from *Camellia sinensis*, herbal formulations integrate a synergy of medicinal plants abundant in vital nutrients and bioactive phytochemicals. Consequently, these drinks are frequently utilized as natural interventions for boosting immune function, aiding digestive health, alleviating stress and mitigating the risk of chronic ailments (Kaur and Kapoor, 2001).

Thefollowingbotanicalsrepresenttheprimaryconstituentsanalyzedinthisstudy:

Mentha spp. (Mint): Widely utilized in ethnomedicine and the food industry, species within the genus Mentha are characterized by a dense profile of bioactive constituents, specifically menthol, flavonoids and phenolic acids. These compounds contribute to documented antioxidant and antimicrobial efficacy while its refreshing organoleptic properties make it a staple in therapeutic infusions (Singh et al., 2008; Bose et al., 2013).

Zingiber officinale (Ginger): Recognized globally for its pharmacological significanceginger contains potent bioactive molecules including gingerols, shogaols and zingerone. These compounds provide a robust defense against oxidative stress and inflammation. Traditionally Z. officinale is employed as a therapeutic agent for gastrointestinal distress, respiratory ailments and chronic inflammatory conditions (Dorman and Hiltunen, 2004)

Withania somnifera (Ashwagandha): Acornerstone of Ayurvedic medicine, Ashwagandha is valued for its adaptogenic and immunomodulatory effects. The plant's therapeutic profile is driven by withanolides, alkaloids, and steroidal lactones, which facilitate physiological resilience, enhanced immune response and improved cognitive health (Gupta and Sharma, 2014).

Glycyrrhizaglabra (Mulethi/Licorice): The medicinal utility of ***G. glabra*** is primarily attributed to its glycyrrhizin, saponin and flavonoid content. Research indicates that these constituents exhibit significant antiviral, antimicrobial and anti-inflammatory activities making it an effective treatment for peptic ulcers and upper respiratory tract infections (Cowan, 1999).

Murraya koenigii (Curry Leaves): Essential to both Indian culinary traditions and herbal medicine, curry leaves are a rich source of carbazole alkaloids and phenolic compounds. These phytochemicals provide a broad spectrum of biological activities, including hepatoprotective, antidiabetic and antioxidant effects (Kaur and Kapoor, 2001).

Cymbopogon citratus (Lemongrass): This aromatic grass is distinguished by high levels of citral and terpenoids. Beyond its characteristic citrus aroma, lemongrass exhibits significant antimicrobial and sedative properties, frequently utilized to enhance digestive health and reduce metabolic stress (Singh et al., 2008).

Ocimum sanctum (Tulsi/Holy Basil): Revered as a sacred botanical in traditional Indian medicine, *O. sanctum* possesses a complex chemical makeup of eugenol and rosmarinic acid. These compound as an immunomodulator and antimicrobial agent, providing systemic protection against fever, stress and various pathogenic infections (Gupta and Sharma, 2014).

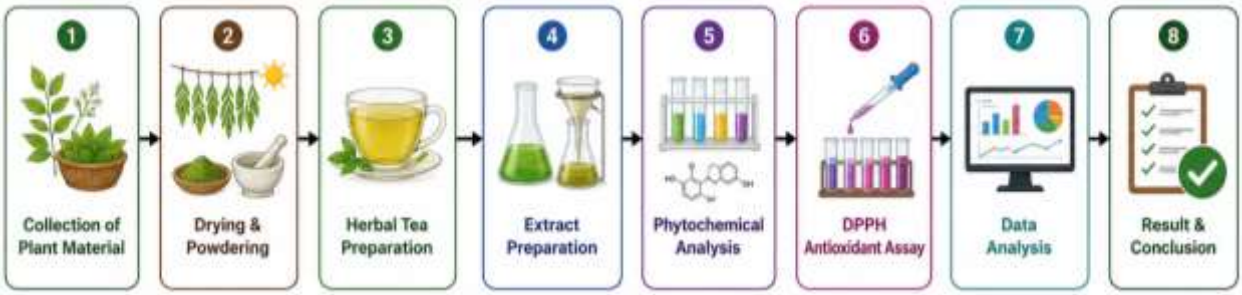
2. Materials and Methods

These medicinal plants were obtained from local markets of Meerut, UP, India, and various nearby locations. The primary botanical components selected for the current investigation include: Mint (*Mentha* spp.), Ginger (*Zingiber officinale*), Ashwagandha (*Withania somnifera*), Mulethi (*Glycyrrhiza glabra*), Curry Leaves (*Murraya koenigii*), Lemongrass (*Cymbopogon citratus*), and Tulsi (*Ocimum sanctum*).

Throughout the collection process strict criteria were followed to pick only those specimens that were fresh and physically healthy. This was essential to ensure that the phytochemical profile of the extracts remains authentic and free from degradation.

Flow Chart:

Collection of Plant Material → Drying & Powdering → Herbal Tea Preparation → Extract Preparation → Phytochemical Analysis → DPPH Antioxidant Assay → Data Analysis → Result & Conclusion



2.1 Collection of Plant Material

Fig:-1 Picture shows raw material used for preparation of herbal green tea (a)Tulsi (b)Mint (c)Lemon Grass (d) Curry Leaves (e) Ginger (f) Ashwagandha (g) Mulethi

2.2 Preparation of Herbal Green Tea

The plant materials were shade-dried and pulverized into fine powder. Individual herbal tea formulations were prepared and stored in airtight containers.

Table 2.2 – Composition of the herbal green tea formulation

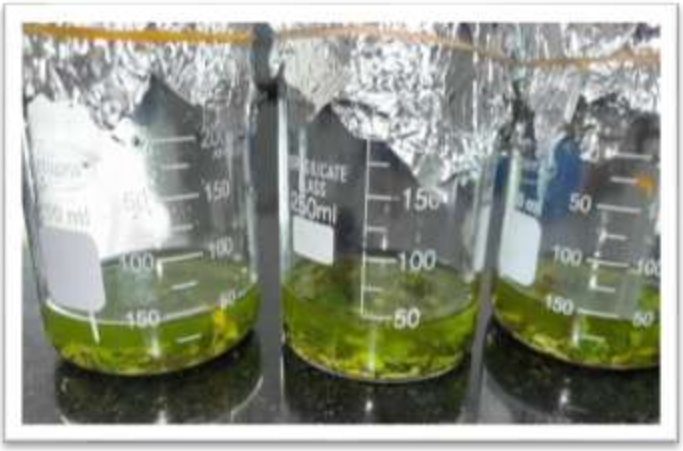
Sr.No.	Ingredient(Common Name)	Scientific Name	Quantity (mg)
1.	Mulethi	***Glycyrrhiza glabra***	250
2.	Ashwagandha	***Withania sonnifera***	200
3.	Tulsi	***Ocimum sanctum***	200
4.	Lemongrass	***Cymbopogon***	200
5.	Curry leaves	***Murraya Koenigii***	200
6.	Ginger (Adrak)	***Zingiber officinale***	150
7.	Mint	***Mentha***	100

Mixed Herbs	Tea Bags	Herbal Tea
		

2.3 Preparation of Extracts

The extraction process was performed using methanol as the primary solvent to isolate the phyto-chemical constituents from the herbal blend. For this procedure, approximately [3] g of the pulverized herbal mixture was submerged in [50] mL of methanol. The suspension was kept for duration of [48] hours with periodic manual shaking to ensure the maximum diffusion of solutes into the solvent.

Extraction of Bioactive Compounds



2.4 Phytochemical Screening

Sr.No.	Phytochemical Group	TestPerformed	Observation	Result
1.	Phenols	FerricChloride Test	Color change (Bluish/Green)	+
2.	Flavonoids	Alkaline ReagentTest	Formationof yellowcolor	+
3.	Alkaloids	Mayer'sTest	Creamy/Whiteppt. formation	+
4.	Tannins	GelatinTest	Whiteppt. formation	+
5.	Saponins	Froth/FoamTest	Persistentfoam formation	+

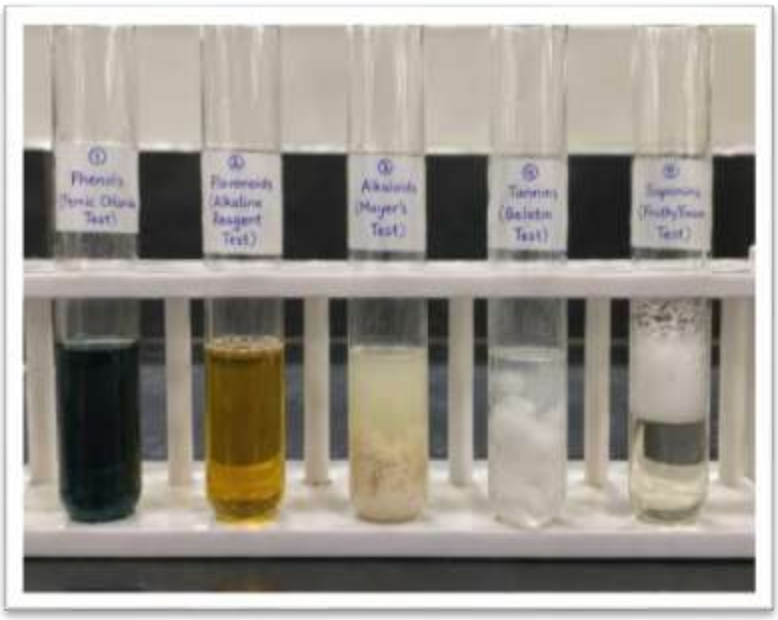


Fig:-2 Picture shows different Antioxidant Activity

2.5 Antioxidant Activity by DPPH Assay

DPPH solution was prepared in methanol. Different herbal tea extracts were mixed with DPPH reagent and incubated in darkness for 30 minutes. Absorbance was measured at 517 nm using a UV-Visible spectrophotometer.

3 RESULTS

3.1 Phytochemical Profile

Preliminary qualitative screening of the methanolic herbal extract revealed a rich diversity of secondary metabolites. The analysis confirmed the presence of key bioactive constituents, including phenols, flavonoids, alkaloids, tannins, saponins, glycosides, and terpenoids. The detection of these phytochemicals underscores the therapeutic potential and medicinal viability of the extract**.**

3.2 DPPH Radical Scavenging Assay

The antioxidant capacity of the herbal extract was evaluated using the DPPH free radical scavenging assay. Across all evaluated concentrations, the extract demonstrated notable antioxidant effects. The

reduction in absorbance recorded at 517 nm directly correlates with the extract's capacity to neutralize free radicals, highlighting its radical scavenging efficacy.

3.3 *In Vitro* Antibacterial Efficacy against *E. coli*

The herbal extract exhibited promising antibacterial properties against *Escherichia coli* across the entire concentration gradient. The zone of inhibition expanded in a dose-dependent manner, peaking significantly at a concentration of 75 µL. However, the reference standard antibiotic maintained a statistically superior zone of inhibition compared to the experimental plant extract**.**

3.4 *In Vitro* Antibacterial Efficacy against *Pseudomonas aeruginosa*

Evaluation against *Pseudomonas aeruginosa* further confirmed the antimicrobial potential of the herbal extract. Similar to the previous assay, the highest inhibitory response was recorded at the 75 µL dosage level. While the extract showed robust activity, the standard antibiotic control yielded the most pronounced zone of inhibition overall.

Table3.1:Qualitative Phytochemical Screening of Methanolic Herbal Extract

Sr.No.	Phytochemical Group Test	Observation	Result
1.	Phenols	Dark green coloration	Present(+)
2.	Flavonoids	Yellow coloration	Present(+)
3.	Alkaloids	Creamy white ppt.	Present(+)
4.	Tannins	Greenish-black color	Present(+)
5.	Saponins	Stable foam formation	Present(+)
6.	Glycosides	Brown ring formation	Present(+)
7.	Terpenoids	Reddish-brown coloration	Present(+)

Table3.2:DPPH Radical Scavenging Profile of the Herbal Extract

Sr.No.	Concentration (µL)	Absorbance (at517 nm)
1.	25µL	1.735
2.	50µL	1.73
3.	75µL	1.795
4.	100µL	1.797

Table 3.3: *Invitro* Antibacterial Activity against *E.coli*

PlateNo.	Standard Antibiotic (mm)	25µLExtract (mm)	50µLExtract (mm)	75µ Extract (mm)	DMSO Control
Plate 1	2.1	0.5	1.0	1.1	0.8
Plate 2	2.0	0.6	0.8	1.1	0.6
Plate 3	2.0	0.6	0.6	1.0	0.5
Plate 4	2.1	1.0	1.1	1.1	0.3

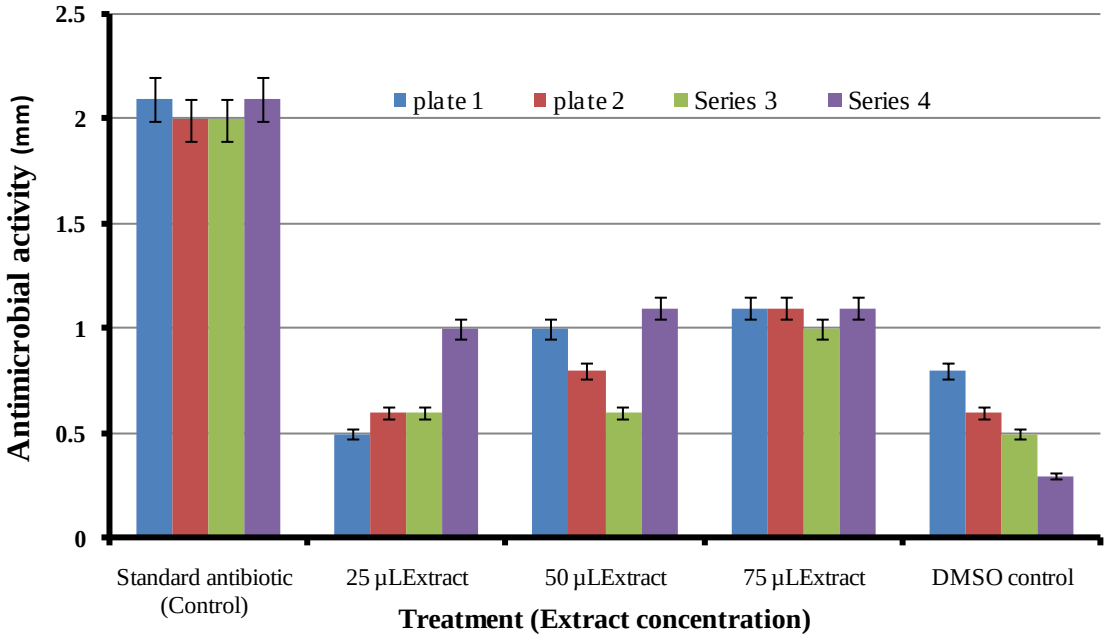


Fig:-3 The antimicrobial activity of the extract against Escherichia coli was observed at all tested concentrations. The standard antibiotic (control) showed the highest zone of inhibition (approximately 2.0–2.1 mm). Among the extract concentrations, 75 µL exhibited the greatest antibacterial activity (approximately 1.0–1.1 mm), followed by 50 µL, while 25 µL showed the lowest inhibition. The DMSO control displayed negligible antimicrobial activity, confirming that the observed antibacterial effect was due to the plant extract.

Table3.4: Antibacterial Activity of Herbal Extract against *Pseudomonas aeruginosa*

PlateNo.	Standard antibiotic(mm)	25µL Extract(mm)	50µL Extract(mm)	75µL Extract(mm)	DMSO Control
Plate 1	2.6	1.34	1.5	1.8	0.8
Plate 2	2.5	0.5	1.0	1.1	0.3
Plate 3	4.0	1.0	1.4	1.1	0.6
Plate 4	3.0	1.6	0.8	1.0	0.7

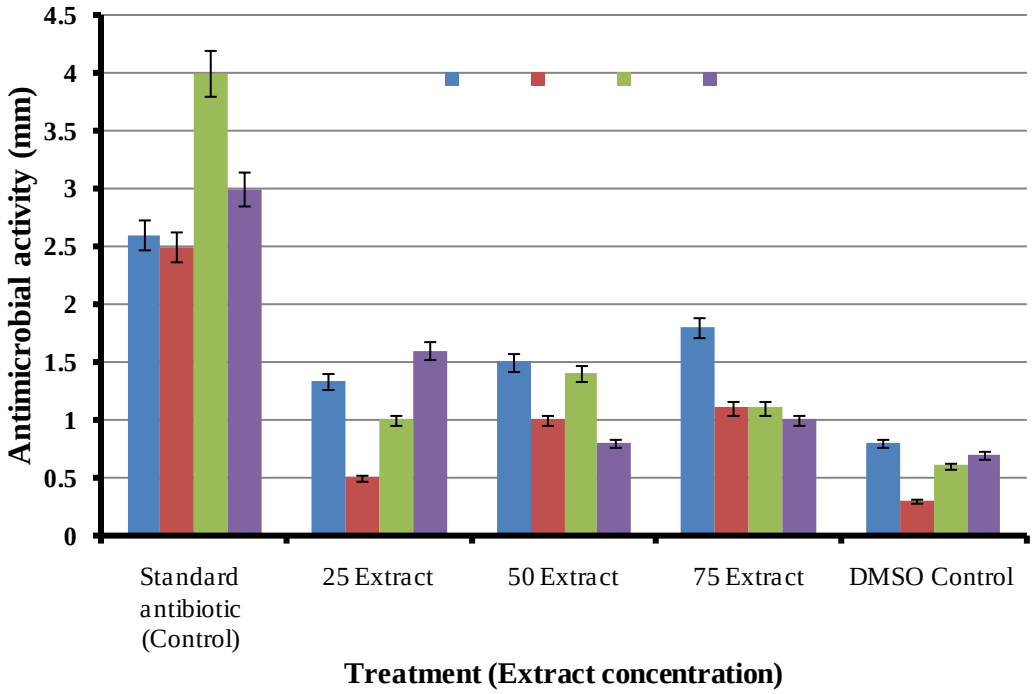


Fig:-4 The antimicrobial activity of the extract against Pseudomonas aeruginosa varied with concentration. The standard antibiotic (control) exhibited the highest zone of inhibition (approximately 2.5–4.0 mm). Among the extract concentrations, 75 mg/mL showed comparatively better inhibitory activity than 25 and 50 mg/mL for some samples, while the DMSO control showed negligible inhibition, confirming that the antimicrobial effect was due to the extract.

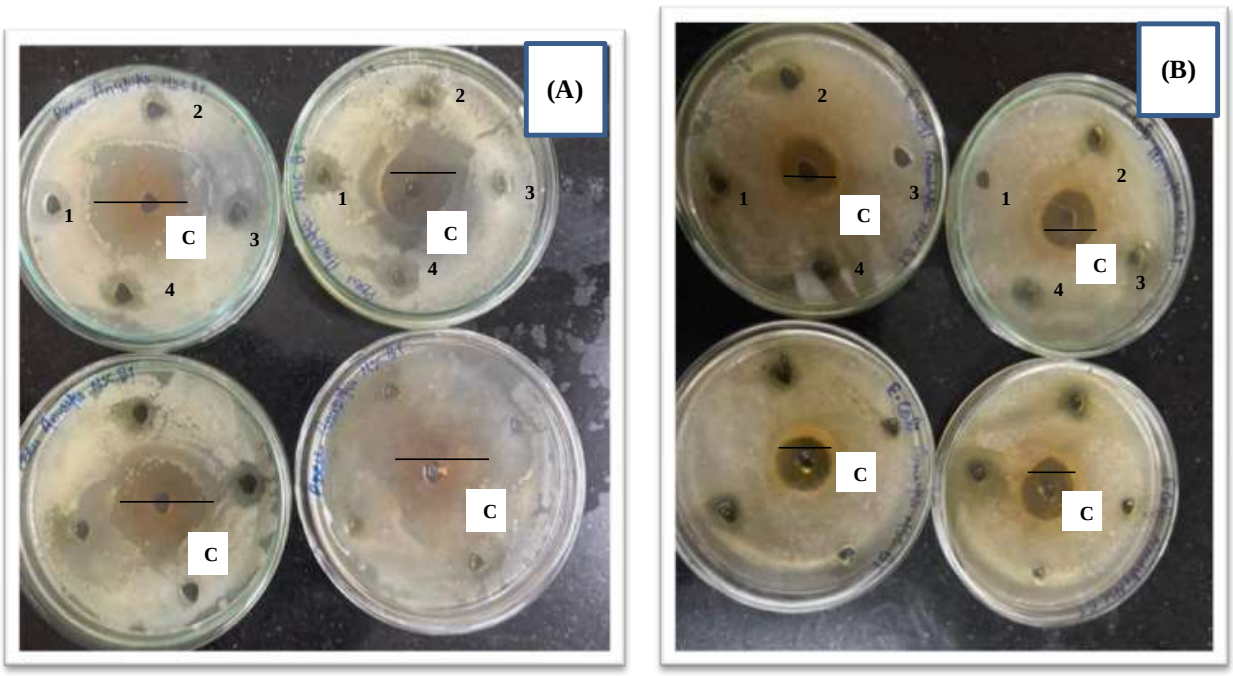


Fig:-5 . Growth inhibition of bacterial strains caused by plant methanolic extracts (extracts includes Tulsi, Mint, Lemongrass, Curry Leaves, Ginger, Ashwagandha, and Mulethi) and +C, positive control (antibiotic).(1). 25 µL Extract (2). 50 µL Extract (3). 75 µL Extract (4). DMSO µL

Extract (mm); Plate (A) shows antimicrobial activity against *Pseudomonas aeruginosa* while plate (B) shows antimicrobial activity against *E.coli*

4. Discussion

The qualitative screening of these blends clearly confirmed the presence of dynamic, biologically active components like flavonoids, polyphenols, alkaloids, tannins, and terpenoids. These particular structural components are widely documented for their extensive therapeutic benefits and high antioxidant behaviors.

The notable radical-neutralizing capacity observed during the DPPH test is primarily driven by these phenols and flavonoids, which easily donate hydrogen atoms to volatile free radicals, thereby rendering them stable. Earlier scientific literature heavily supports these results, confirming that herbs like tulsi, ginger, mint, and lemongrass naturally carry high concentrations of polyphenols, translating directly into superior antioxidant performance.

The results gathered in this research align perfectly with historical data, confirming that medicinal plant concentrates hold impressive free radical scavenging potential. Consequently, these findings reinforce the idea that these custom herbal green tea blends can serve as exceptional, health-promoting wellness beverages rich in natural antioxidants.

5. Conclusion

In summary, this study validates that herbal green tea variations prepared from selected medicinal plants are rich in vital phytochemical markers and deliver impressive antioxidant action. The presence of core compounds like phenols, flavonoids, alkaloids, and tannins directly empowers their free radical scavenging mechanics. As a result, these specialized teas stand out as excellent functional drinks aimed at enhancing physical well-being and mitigating disorders stemming from oxidative stress. Moving forward, it is recommended to conduct deeper quantitative phytochemical analyses alongside in vivo biological studies to unlock their full medical potential.

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