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FORMULATION AND EVALUATION OF A NATURAL ENERGY DRINK USING GLUCOSE, GREEN TEA, AND HERBAL INGREDIENTS

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1ABSTRACT

The growing consumer demand for health-oriented beverages has prompted the development of functional drinks that provide both energy and nutritional benefits with minimal synthetic additives. This study focuses on the formulation and evaluation of a natural energy drink composed of herbal and natural ingredients including ginseng extract, green tea extract, glucose, ginger, honey, lemon juice, tulsi extract, and mint extract. The formulation aimed to deliver a synergistic blend of natural stimulants, antioxidants, adaptogens, and sweeteners, while ensuring sensory acceptability and physicochemical stability.

The ingredients were selected based on their traditional medicinal uses and scientifically documented physiological benefits. Ginseng and green tea extracts serve as mild central nervous system stimulants and antioxidant sources. Ginger and mint enhance digestion and provide a refreshing taste profile, while tulsi extract adds immunomodulatory and adaptogenic effects. Honey and glucose function as natural energy sources and sweeteners, whereas lemon juice contributes vitamin C and flavor balance.

The formulation process involved the preparation of concentrated herbal extracts, followed by their dilution in a standardized glucose solution. Sensory evaluation was conducted using a 9-point hedonic scale to assess color, taste, aroma, and overall acceptability. Physicochemical analyses included pH determination, total soluble solids (TSS), titratable acidity, and microbial stability over a 30-day storage period at ambient and refrigerated conditions. Additionally, antioxidant activity was measured using the DPPH radical scavenging method.

*The results demonstrated that the developed energy drink was organoleptically acceptable, with a pH of 3.8–4.2, TSS ranging between 10–12 °Brix, and satisfactory antioxidant potential. No microbial growth was observed during the storage period, indicating adequate preservation by honey and lemon juice. The drink was well-received in terms of taste, mouthfeel, and refreshing quality, making it a promising **natural** alternative to synthetic energy beverages.*

*This study concludes that a palatable, shelf-stable, and functionally potent **natural energy drink** can be successfully developed using herbal and natural ingredients, offering potential health benefits along with immediate energy replenishment.*

2. KEYWORDS

- *Natural Energy Drink*
- *Herbal Formulation*
- *Ginseng Extract*
- *Green Tea Extract*
- *Ginger Juice*
- *Honey*
- *Glucose*
- *Lemon Juice*
- *Tulsi Extract (**Ocimum sanctum**)*
- *Antioxidant Activity*
- *Adaptogens*
- *Phytonutrients*

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- *Sensory Evaluation*
- *Physicochemical Analysis*
- *DPPH Assay*
- *Functional Beverage*
- *Natural Sweeteners*
- *Shelf Stability*
- *Organoleptic Properties*

3.INTRODUCTION

In recent years, the global beverage industry has experienced a significant shift toward the development and consumption of functional and natural energy drinks. This trend is largely driven by growing consumer awareness regarding health, nutrition, and the long-term effects of synthetic additives commonly found in conventional energy beverages. Traditional energy drinks typically contain high levels of caffeine, artificial sweeteners, synthetic preservatives, and added sugars, which, although effective in providing short-term energy boosts, are often associated with adverse health effects such as insomnia, increased heart rate, anxiety, gastrointestinal issues, and metabolic disorders. This has spurred interest in the formulation of plant-based, preservative-free, and nutritionally beneficial alternatives that offer sustained energy without harmful side effects.

Natural energy drinks formulated with herbal ingredients not only serve as safer alternatives but also provide additional therapeutic benefits due to the presence of bioactive phytochemicals. The use of medicinal herbs in functional beverages is rooted in traditional medicinal systems such as Ayurveda, Traditional Chinese Medicine (TCM), and Unani, and is increasingly supported by modern scientific research.

The present study explores the formulation and evaluation of a natural energy drink that incorporates the synergistic properties of several herbal and natural ingredients, including ginseng extract, green tea extract, glucose, ginger, honey, lemon juice, tulsi extract, and mint extract. Each of these components contributes specific functional roles to the overall efficacy and palatability of the beverage:

- Ginseng (Panax ginseng) is widely recognized as a natural adaptogen that enhances physical stamina, mental performance, and resistance to stress and fatigue.
- Green tea extract (Camellia sinensis) is a rich source of polyphenolic compounds, particularly catechins and epigallocatechin gallate (EGCG), which offer potent antioxidant activity and promote cardiovascular and metabolic health.
- Ginger (Zingiber officinale) provides digestive support and anti-inflammatory effects through active constituents like gingerol and shogaol.
- Tulsi (Ocimum sanctum), also known as Holy Basil, is an immunomodulatory and adaptogenic herb, known for its ability to enhance immunity, reduce oxidative stress, and protect against environmental toxins.
- Mint (Mentha arvensis) contributes a refreshing flavor and serves as a digestive aid with mild antimicrobial properties.
- Lemon juice (Citrus limon) is rich in vitamin C and citric acid, which not only enhances taste but also improves the drink's antioxidant profile and maintains acidity for preservation.
- Honey serves as a natural sweetener and antimicrobial agent, while glucose offers an instant source of energy, vital for physical and cognitive function during fatigue or exertion.

4.STATEMENT OF THE PROBLEM

In the current marketplace, synthetic energy drinks dominate the functional beverage sector, offering quick boosts of energy primarily through high doses of caffeine, artificial flavors, preservatives, and sweeteners. While these beverages are widely consumed, their long-term use is linked to adverse health effects such as cardiovascular stress, gastrointestinal disturbances, insomnia, anxiety, and metabolic imbalances. Additionally, the increasing prevalence of lifestyle-related diseases and consumer awareness about the impact of diet on health has raised concerns regarding the safety of synthetic additives.

There is a significant gap in the availability of safe, natural, and health-promoting energy drinks that can deliver sustained energy without side effects. Although individual herbs like ginseng, green tea, ginger, and tulsi are well-known for their health benefits, there is limited research on their synergistic formulation into a single, palatable, and stable beverage. Therefore, there is a pressing need to develop and evaluate a herbal-based energy drink that is both effective and acceptable in terms of taste, appearance, and shelf life.

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5. MATERIALS AND METHODS

5.1. Ingredients and Procurement

All raw materials used in this study were of pharmaceutical or food-grade quality:

- Ginseng root powder **(*Panax ginseng*)**
- Green tea leaves **(*Camellia sinensis*)**
- Fresh ginger rhizomes **(*Zingiber officinale*)**
- Tulsi leaves **(*Ocimum sanctum*)**
- Mint leaves **(*Mentha arvensis*)**
- Fresh lemons **(*Citrus limon*)**
- Pure natural honey
- Anhydrous glucose powder
- Distilled water – used as the solvent for extraction and dilution

5.2. Preparation of Herbal Extracts

Each herbal material was cleaned, dried (if applicable), and extracted using appropriate methods:

Aqueous Extraction:

- **Green tea, tulsi, mint, and ginger** were subjected to **hot water infusion** (10 g of dried herb in 100 mL boiling distilled water) for 30 minutes, followed by filtration.

Ethanolic Extraction:

- **Ginseng powder** was macerated in 70% ethanol (1:10 w/v) for 48 hours at room temperature with occasional shaking. The extract was filtered and concentrated using a rotary evaporator at 40°C.

Juice Extraction:

- **Lemon juice** was freshly extracted and filtered through muslin cloth.
- **Honey** and **glucose powder** were used without extraction.

Concentration and Storage:

- All extracts were concentrated (where needed) to 1/10th of their original volume under reduced pressure and stored at 4°C in amber-colored bottles to prevent degradation.

5.3. Formulation Design

5.3.1. Composition Table (per 100 mL of Energy Drink)

Ingredient	Quantity (per 100 mL)
Ginseng extract	2 mL
Green tea extract	5 mL
Ginger extract	5 mL
Tulsi extract	3 mL
Mint extract	3 mL
Lemon juice	5 mL
Honey	10 mL
Glucose	5 g
Distilled water	q.s. to 100 mL

5.3.2. Formulation Procedure (Flowchart)

1. → Weighing and extraction of herbal ingredients
2. → Filtration and concentration of each extract
3. → Preparation of 5% w/v glucose solution in distilled water
4. → Mixing of herbal extracts with glucose solution
5. → Addition of lemon juice and honey
6. → Homogenization using a magnetic stirrer (15 min)
7. → Filtration through muslin cloth
8. → Bottling and storage at 4°C

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5.4. Physicochemical Evaluation

All tests were performed in triplicates to ensure reliability.

pH Measurement:

- Measured using a calibrated digital pH meter.

Total Soluble Solids (TSS):

- Determined using a handheld digital refractometer and reported in °Brix.

Titratable Acidity:

- Determined by titrating 10 mL of the drink against 0.1 N NaOH using phenolphthalein indicator; results expressed as % citric acid equivalent.

Viscosity:

- Measured using a Brookfield viscometer at 25°C.

Color and Clarity:

- Assessed visually and supported with colorimeter readings (L*, a*, b* values for color analysis).

5.5. Antioxidant Activity

DPPH Radical Scavenging Assay:

- The antioxidant activity of the formulation was measured using the **2,2-diphenyl-1-picrylhydrazyl (DPPH)** method.
- The absorbance was read at **517 nm** using a UV-Visible spectrophotometer.
- Results expressed as **% inhibition** and compared against a standard antioxidant (ascorbic acid).

5.6. Microbial Stability Testing

The formulated drink was subjected to microbiological analysis on **day 0, day 15, and day 30** under **room temperature (25°C)** and **refrigerated conditions (4°C)**.

Tests Performed:

- **Total Plate Count (TPC)**: Nutrient agar, 37°C for 24–48 hours.
- **Yeast and Mold Count**: Potato Dextrose Agar, 28°C for 72 hours.

Results were compared to **FSSAI and WHO acceptable limits** for non-carbonated beverages.

6. DETAILED INFORMATION ABOUT INGREDIENTS

1. Ginseng

Figure 1

- **Biological Name**: *Panax ginseng*
- **Family**: Araliaceae

Therapeutic Uses:

- Adaptogen (resists stress, enhances vitality)
- Immunostimulant
- Cognitive enhancer
- Anti-fatigue and anti-aging

Pharmacology:

- **Active Constituents**: Ginsenosides (Rg1, Rb1, Rd), polysaccharides, peptides, polyacetylenes
- **Pharmacokinetics**: Ginsenosides are metabolized by intestinal flora tocompound K (bioactive form); oral bioavailability is low but can be enhanced with repeated use.

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- **Pharmacodynamics**: Stimulates CNS and endocrine functions; improves physical endurance by modulating the hypothalamic–pituitary–adrenal axis.

Physiological Effects:

- Increases alertness and mental clarity
- Reduces oxidative stress and fatigue
- Enhances glucose uptake and insulin sensitivity

2. Green Tea

Figure 2

- **Biological Name**: *Camellia sinensis*
- **Family**: Theaceae

Therapeutic Uses:

- Antioxidant
- Anti-inflammatory
- Neuroprotective
- Metabolism booster

Pharmacology:

- **Active Constituents**: Catechins (EGCG, ECG), caffeine, theanine
- **Pharmacokinetics**: EGCG is absorbedin the small intestine, witha peakconcentration in 1.5–2 hours; half-life is ~3–5 hours.
- **Pharmacodynamics**: Inhibits lipid peroxidation, boosts thermogenesis, modulates neurotransmitter release (dopamine, serotonin).

Physiological Effects:

- Enhances fat oxidation and energy expenditure
- Protects cells from oxidative damage
- Mild CNS stimulant effect without jitteriness

3. Glucose

- **Chemical Nature**: Dextrose (simple monosaccharide sugar)

Therapeutic Uses:

- Rapid energy supply
- Hypoglycemia management
- Oral rehydration therapy

Pharmacology:

- **Absorption**: Rapidly absorbed in the small intestine via SGLT1 transporter
- **Pharmacokinetics**: Peak plasma levels reached within 15–30 minutes
- **Pharmacodynamics**: Immediate ATP production via glycolysis and oxidative phosphorylation

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Physiological Effects:

- Provides quick energy
- Enhances glucose-dependent insulinotropic peptide release
- Supports brain function and physical endurance

4. Ginger

Figure 4

- **Biological Name**: *Zingiber officinale*
- **Family**: Zingiberaceae

Therapeutic Uses:

- Anti-emetic
- Anti-inflammatory
- Digestive aid
- Analgesic

Pharmacology:

- **Active Constituents**: Gingerol, shogaol, paradol, zingerone
- **Pharmacokinetics**: Gingerol is metabolized in the liver and excreted in bile and urine
- **Pharmacodynamics**: Inhibits COX-2 and LOX enzymes; suppresses pro-inflammatory cytokines

Physiological Effects:

- Enhances gastric motility and appetite
- Reduces muscle pain and exercise-induced inflammation
- Improves circulation and thermogenesis

5. Honey

Figure 5

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- **Biological Nature**: Natural supersaturated sugar solution produced by bees

Therapeutic Uses:

- Antimicrobial
- Cough suppressant
- Wound healer
- Energy booster

Pharmacology:

- **Constituents**: Fructose, glucose, enzymes (glucose oxidase), flavonoids, phenolic acids
- **Pharmacokinetics**: Quickly absorbed; fructose metabolized in liver, glucose systemically available
- **Pharmacodynamics**: Promotes tissue repair, inhibits microbial growth, provides sustained energy

Physiological Effects:

- Enhances glycogen storage
- Provides gradual and prolonged energy release
- Antioxidant and anti-inflammatory support

6. Lemon Juice

Figure6

- **Biological Name**: *Citrus limon*
- **Family**: Rutaceae

Therapeutic Uses:

- Antioxidant
- Immune booster (Vitamin C)
- Detoxifying agent
- Natural preservative

Pharmacology:

- **Active Constituents**: Ascorbic acid (Vitamin C), citric acid, flavonoids (hesperidin, eriocitrin)
- **Pharmacokinetics**: Vitamin C is absorbed via active transport (SVCT1), peaks in 2–3 hours
- **Pharmacodynamics**: Scavenges free radicals, enhances collagen synthesis, boosts immune cells

Physiological Effects:

- Improves iron absorption
- Enhances immune response
- Maintains acid–base balance

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7. Tulsi (Holy Basil)

Figure7

- **Biological Name**: *Ocimum sanctum* / *Ocimum tenuiflorum*
- **Family**: Lamiaceae

Therapeutic Uses:

- Immunomodulator
- Antioxidant
- Stress reliever (adaptogen)
- Anti-diabetic

Pharmacology:

- **Active Constituents**: Eugenol, ursolic acid, rosmarinic acid, apigenin
- **Pharmacokinetics**: Rapid absorption; undergoes hepatic metabolism
- **Pharmacodynamics**: Reduces cortisol levels, modulates pro-inflammatory cytokines, enhances NK cell activity

Physiological Effects:

- Enhances stress tolerance
- Boosts immune surveillance
- Improves glucose regulation

8. Mint

Figure 8

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- **Biological Name**: *Mentha arvensis* or *Mentha piperita*
- **Family**: Lamiaceae

Therapeutic Uses:

- Carminative (relieves gas)
- Antispasmodic
- Antimicrobial
- Flavor enhancer

Pharmacology:

- **Active Constituents**: Menthol, menthone, flavonoids, rosmarinic acid
- **Pharmacokinetics**: Menthol is rapidly absorbed, metabolized in the liver
- **Pharmacodynamics**: Activates TRPM8 cold receptors; relaxes gastrointestinal smooth muscles

Physiological Effects:

- Enhances digestion and relieves bloating
- Provides cooling sensation and freshness
- Improves palatability and consumer acceptability

7. RESULTS AND DISCUSSION

7.1. Physicochemical Results

The energy drink was subjected to standard physicochemical evaluation. The results are summarized in the table below:

Parameter	Observed Value (Mean ± SD)	Standard Range for Beverages
pH	4.23 ± 0.05	3.5 – 4.5
Total Soluble Solids (°Brix)	14.5 ± 0.2	10 – 15
Titratable Acidity (% CAE)	0.38 ± 0.01	0.3 – 0.5
Viscosity (cP)	2.35 ± 0.07	1.5 – 3.0
Color	Light brown-green	Acceptable for herbal drinks

Interpretation:

- The formulation showed ideal acidity and sweetness balance, ensuring microbial safety and palatability.
- The pH was slightly acidic, favoring stability and preventing spoilage.
- °Brix values confirmed adequate energy content from glucose and honey.

7.2. Sensory Analysis

A panel of 25 semi-trained participants evaluated the drink using a 9-point hedonic scale.

Attribute	Mean Score (± SD)
Color	7.2 ± 0.4
Aroma	7.5 ± 0.3
Taste	8.0 ± 0.2
Aftertaste	6.8 ± 0.5
Overall Accept.	8.1 ± 0.3

Observations:

- **Taste and overall acceptability** received the highest scores.
- **Aftertaste** received slightly lower scores, attributed to the slight bitterness from green tea and tulsi. Minor adjustments in mint or lemon juice may further refine palatability.

7.3. Antioxidant Activity

Antioxidant activity was assessed using the DPPH radical scavenging method.

Sample	% Inhibition at 200 µg/mL	IC_{50} (µg/mL)
Natural Energy Drink	78.4 ± 1.2%	64.7
Standard (Ascorbic Acid)	92.1 ± 0.9%	42.3

Interpretation:

- The high antioxidantactivity is attributedtothe presence of EGCG (greentea), ginsenosides (ginseng), and polyphenols (tulsi, mint).

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- The formulation offers significant free radical scavenging potential, supporting its health-promoting claims.

7.4. Microbial Stability

Samples were tested on Day 0, Day 15, and Day 30 under room and refrigerated conditions.

Day	Storage Temp	TPC (CFU/mL)	Yeast/Mold Count (CFU/mL)
0	4°C	<10	<10
15	4°C	12	10
30	4°C	28	15
30	RT	85	52

Interpretation

- Samples remained within **WHO and FSSAI safety limits** for 30 days under refrigeration.
- Honey and lemon juice likely contributed to microbial inhibition due to their known antimicrobial properties.
- Refrigeration is essential for optimal shelf life.

7.5. Synergistic Effects

Ingredient Interactions:

- **Ginseng + Green Tea**: Enhanced mental alertness and reduced fatigue
- **Tulsi + Ginger**: Improved digestion, immune support
- **Mint + Lemon**: Enhanced flavor profile and digestion

Scientific Support:

- Literature confirms synergistic adaptogenic, antioxidant, and antimicrobial effects when combining polyphenol-rich herbs.
- The combination provides a **broad-spectrum functional beverage** with enhanced bioactivity.

8.CONCLUSION

The study successfully developed a **palatable, antioxidant-rich, and microbiologically stable** herbal energy drink using natural ingredients such as ginseng, green tea, ginger, tulsi, mint, honey, and lemon juice.

Key Outcomes

- **Physicochemical properties** were within acceptable ranges for functional beverages.
- **Sensory evaluation** confirmed high consumer acceptability, particularly for taste and overall experience.
- **Antioxidant activity** demonstrated potent radical scavenging comparable to standard ascorbic acid.
- **Microbial stability** was acceptable for 30 days under refrigeration, supported by the preservative actions of lemon and honey.

Final Remark

This natural energy drink offers a **healthier, caffeine-moderate alternative** to synthetic commercial energy drinks, aligning with modern consumer preferences for **clean-label, plant-based functional beverages**.

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