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Formulation And Development Of Herbal Energy Drinks Using Moringa And Ginger

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INTRODUCTION

Energy drinks have become a popular beverage category worldwide, primarily consumed to boost energy, enhance mental alertness, and improve physical performance. However, most commercially available energy drinks contain high levels of caffeine, artificial sweeteners, synthetic additives, and excessive sugar, which have been linked to various health risks such as cardiovascular diseases, metabolic disorders, obesity, and nervous system disturbances. The increasing health consciousness among consumers has led to a growing demand for natural and healthier alternatives to conventional energy drinks. As a result, the development of herbal-based energy drinks has gained significant attention, with a focus on utilizing plant-based ingredients that provide both energy and additional health benefits.

Among the numerous medicinal plants with potential energy-boosting effects, Moringa (*Moringa oleifera*) and Ginger (*Zingiber officinale*) have been widely recognized for their nutritional and pharmacological properties. Moringa, often referred to as the “Miracle Tree,” is rich in essential vitamins, minerals, amino acids, and antioxidants that contribute to overall health and well-being. It is known to enhance stamina, reduce fatigue, and improve immune function due to its high content of iron, vitamin C, and bioactive compounds. Similarly, Ginger, a widely used spice and medicinal herb, possesses stimulating, anti-inflammatory, and digestive-enhancing properties. It is traditionally known to improve blood circulation, relieve fatigue, and promote thermogenesis, making it a suitable component for an energy-enhancing herbal drink.

KEYWORDS Formulation, Development, Nutritional Analysis, Antioxidant Properties, Phytochemicals, Functional Beverages , Caffeine-free Energy

ABSTRACT

This research explores the formulation and development of a herbal energy drink utilizing Moringa (*Moringa oleifera*) and Ginger (*Zingiber officinale*) as key ingredients. Moringa is known for its rich nutritional profile, including proteins, vitamins, and antioxidants, while Ginger is valued for its bioactive compounds that enhance metabolism and provide energy. The study focuses on optimizing the formulation for taste, stability, and bioactive retention while evaluating its functional and energy-boosting properties.

The formulation process involves optimizing the ratio of Moringa and Ginger extracts, selecting natural sweeteners, and evaluating physicochemical stability. The drink's nutritional profile, sensory acceptability, and functional properties were analyzed through laboratory testing and consumer evaluation. Results indicate that the herbal energy drink is a viable alternative to commercial energy drinks, offering enhanced metabolism, antioxidant benefits, and improved overall wellness. This study highlights the potential of herbal-based functional beverages in promoting a healthier lifestyle.

DRUG PROFILE

A) Moringa

Moringa (*Moringa oleifera*) is a nutritional powerhouse and medicinal plant with a rich profile of vitamins, minerals, antioxidants, and bioactive compounds. Its combination of nutritional benefits and therapeutic properties makes it an excellent ingredient in herbal energy drinks, functional foods, and natural medicine. Regular consumption of Moringa can boost immunity, enhance energy levels, support cardiovascular health, and improve overall well-being.

- Synonyms of Moringa:- Drumstick Tree, Miracle Tree, Horseradish Tree, Ben Oil Tree, Malunggay, Sajna, Shevaga, Shigru, Murungai.
- Chemical Constituents of moringa:- Moringa contains alkaloids (moringinine), flavonoids (quercetin, kaempferol), phenolic compounds (chlorogenic acid, caffeoylquinic acid), glucosinolates, isothiocyanates, saponins, tannins, and essential fatty acids (omega-3 & omega-6).
- Nutritional Properties of Moringa:-
 - Vitamin A (Beta-carotene): Supports vision, immunity, and skin health.
 - Vitamin C: A powerful antioxidant that boosts the immune system.
 - Vitamin E: Protects cells from oxidative stress and promotes heart health.
 - B Vitamins (B1, B2, B3, B6): Support energy metabolism and brain function.
- Medicinal Properties of Moringa:-
 - Antioxidant & Anti-Aging Properties
 - Anti-Inflammatory Effects
 - Blood Sugar Regulation



Fig(1):- Moringa leaf

A) Ginger

Ginger (*Zingiber officinale*) is a nutrient-rich medicinal spice with powerful antioxidant, anti-inflammatory, digestive, and immune-boosting properties. Its key bioactive compounds, including gingerol, shogaol, and zingerone, contribute to its therapeutic benefits in managing pain, digestive issues, infections, and chronic diseases. With its rich nutritional profile and traditional medicinal uses, Ginger remains a valuable natural remedy in both herbal medicine and modern functional foods.

- **Synonyms of Ginger:-** Ginger (*Zingiber officinale*) is also known as Adrak (Hindi), Shunti (Sanskrit), Jiang (Chinese), Ingwer (German), Gengibre (Spanish), and Gingembre (French).
- **Chemical Constituents of Ginger:-** Ginger contains phenolic compounds (gingerol, shogaol, zingerone), essential oils (zingiberene, camphene, β -phellandrene), flavonoids (quercetin, kaempferol), and polysaccharides, contributing to its medicinal properties.
 - **Nutritional Properties of Ginger:-**
 - Carbohydrates: Provides natural energy and supports metabolism.
 - Dietary Fiber: Aids digestion and gut health.
 - Proteins & Fats: Present in small amounts but contribute to cellular function.
 - Gingerol: A powerful anti-inflammatory and antioxidant compound.
 - Shogaol: Provides pain relief and supports digestion.
 - Zingerone: Exhibits antimicrobial and anti-diarrheal effects.
 - **Medicinal Properties of Ginger:-**
 - Anti-Inflammatory & Antioxidant Properties
 - Regulates Blood Sugar & Supports Heart Health
 - Pain Relief & Anti-Spasmodic Effects

- Anti-Cancer Properties
- Supports Brain Function & Mental He



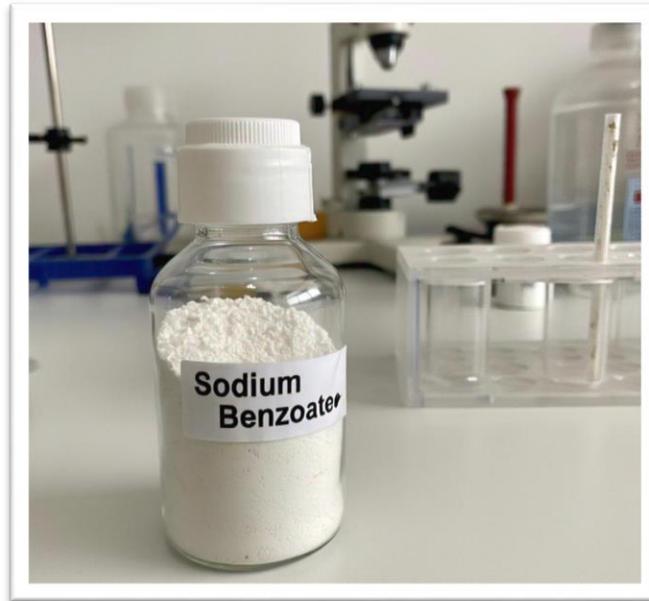
Fig(2):- Ginger

EXCIPIENT PROFILE

Excipients play a crucial role in enhancing the stability, taste, texture, and overall acceptability of the herbal energy drink. The following excipients are included in the formulation:

- **Lemon Juice (Acidulant & Flavor Enhancer)**
 - Main Constituents: Citric acid, ascorbic acid (vitamin C), flavonoids, sugars (glucose, fructose), minerals (potassium, calcium), water, essential oils (limonene in peel)
 - Functional Categories: Acidifying agent, antioxidant, flavoring agent, pH modifier
 - Physical Description: Clear yellowish liquid; strong sour taste and citrus aroma
 - Solubility: Completely miscible in water
 - pH Range: ~2.0 – 3.0
 - Pharmaceutical Uses: Flavor enhancer in oral preparations to mask bitter tastes, Acidulate to adjust pH in formulations, Antioxidant (ascorbic acid can inhibit oxidation of sensitive drugs), Chelating agent (citric acid can bind metals)
 - Compatibility: Compatible with most water-soluble APIs and excipients. Potential incompatibility with alkaline substances (may cause precipitation or degradation). May complex with some metals.
 - Safety and Regulatory Status: Generally recognized as safe (GRAS) for oral use. Allergic reactions are rare but possible. Regulatory status depends on the country and intended concentration (used more often in food/dietary supplements than pharmaceuticals).

- **Honey (Natural Sweetener & Preservative)**
 - Category: Sweetener, preservative, demulcent, viscosity modifier, flavor enhancer
 - Appearance: Thick, golden to amber viscous liquid with floral aroma
 - Main Constituents: Fructose, glucose, sucrose, water, enzymes, acids, vitamins, minerals, flavonoids
 - Solubility: Completely water-soluble
 - pH: ~3.4 – 6.1 (typically ~3.9)
 - Uses: Sweetener in syrups/lozenges, preservative, demulcent in cough preparations, wound healing agent
 - Stability: Hygroscopic, crystallizes on storage, sensitive to heat (>40°C), low spoilage risk
 - Compatibility: Compatible with water-soluble APIs, incompatible with strong oxidizers
 - Safety: GRAS; avoid in infants <1 year (risk of infant botulism)
 - Notes: Antimicrobial via osmotic effect, acidity, and hydrogen peroxide release
- **Water (Solvent & Carrier Medium)**
 - Category: Solvent, carrier, vehicle, diluent
 - Appearance: Clear, colorless, odorless, tasteless liquid
 - Main Constituents: Pure H₂O (may contain trace dissolved gases and ions depending on grade)
 - Solubility: Universal solvent (dissolves many ionic and polar compounds)
 - pH: ~5.0 – 7.0 (depends on CO₂ content and grade)
 - Uses: Solvent in oral/parenteral/topical products, carrier for APIs, reconstitution of powders
 - Stability: Stable under normal conditions; prone to microbial contamination if not preserved
 - Compatibility: Compatible with most excipients/APIs; hydrolysis risk with water-sensitive drugs
 - Safety: GRAS; highly safe when purified (various pharmacopeial grades available)
 - Notes: Pharmaceutical grades include Purified Water, Water for Injection (WFI), Sterile Water, etc.
- **Sodium Benzoate (Preservative)**
 - Category: Antimicrobial preservative, antifungal agent
 - Appearance: White, crystalline powder or granules; odorless; slightly sweetish taste
 - Main Constituents: Sodium salt of benzoic acid (C₇H₅NaO₂)
 - Solubility: Freely soluble in water; sparingly soluble in alcohol
 - pH: Most effective at pH < 5.5 (optimum antimicrobial action in acidic media)
 - Uses: Preservative in oral liquids, syrups, suspensions, topical and cosmetic products
 - Stability: Stable under normal storage; hydrolysis to benzoic acid possible in acidic conditions
 - Compatibility: Compatible with most excipients; less effective in alkaline pH
 - Safety: GRAS; acceptable daily intake (ADI) established; well-tolerated at permitted levels
 - Notes: Antimicrobial action by inhibiting microbial enzyme systems; works best in acidic formulations



Fig(3):- Sodium Benzoate

PLAN OF WORK

The development of a herbal energy drink involves several systematic steps to ensure quality, safety, and effectiveness. The following plan outlines the step-by-step process:

Selection of Ingredients

The selection of high-quality ingredients is a crucial step in developing a nutritious, safe, and effective herbal energy drink. Each ingredient plays a specific role in contributing to the flavor, nutritional profile, medicinal benefits, and stability of the final product. Below is a detailed explanation of the selected ingredients

- Moringa Leaves (*Moringa oleifera*)
 - Reason for Selection: Moringa is a nutritional powerhouse packed with essential vitamins, minerals, proteins, and antioxidants that provide energy, immune support, and overall wellness.
 - Form Used: Fresh leaves or dried leaves in powdered form for better solubility and bioavailability.
 - Selection Criteria: Leaves should be fresh, green, and free from pesticides to retain maximum nutrients.
- Ginger Root (*Zingiber officinale*)
 - Reason for Selection: Ginger is widely known for its stimulant, anti-inflammatory, and digestive-enhancing properties, making it a key component in an energy drink.
 - Form Used: Fresh ginger root (grated/sliced) or dried ginger powder for effective infusion.
 - Selection Criteria: The root should be fresh, firm, and free from mold, ensuring maximum potency and flavor.
- Lemon Juice (*Citrus limon*)
 - Reason for Selection: Honey is chosen as a natural alternative to artificial sweeteners, adding mild sweetness and health benefits.
 - Form Used: Freshly squeezed lemon juice to maintain natural freshness and aroma.

- Selection Criteria: Lemons should be fresh, juicy, and free from pesticides to ensure a high vitamin C content.
- Honey
 - Reason for Selection: Honey is chosen as a natural alternative to artificial sweeteners, adding mild sweetness and health benefits.
 - Form Used: Pure, raw, or organic honey for maximum nutritional benefits.
 - Selection Criteria: Honey should be free from additives, unprocessed, and sourced from natural beekeeping practices.
- Water
 - Reason for Selection: Water is the primary solvent used to extract active compounds from Moringa and Ginger and to ensure proper hydration.
 - Form Used: Filtered, purified, or distilled water to prevent contamination and ensure drink safety.
 - Selection Criteria: Water should be free from contaminants, chemicals, and heavy metals.
- Sodium Benzoate
 - Reason for Selection: Used to extend the shelf life of the drink by preventing microbial growth and spoilage.
 - Form Used: Added in a permissible concentration (typically 0.1% or as per regulatory guidelines).
 - Selection Criteria: Should be food-grade, used within safety limits, and compatible with acidic beverages like those containing lemon juice.

Preparation of Herbal Energy Drink

The preparation of the herbal energy drink follows controlled steps to ensure nutrient extraction and stability. Moringa leaves are washed, dried, and ground, while ginger is washed, peeled, and grated or sliced. Lemon juice is filtered for acidity balance, and honey is added as a natural sweetener .

Quality Control and Analytical Testing

Quality control and analytical testing are essential steps in ensuring that the herbal energy drink meets safety, efficacy, and stability standards. These tests help verify the nutritional composition, physicochemical properties, microbial safety, and sensory acceptability of the final product.

- Physicochemical Analysis
 - pH Testing: A pH meter is used to measure the acidity level of the drink, ensuring it falls within a safe and stable range (typically 3.0–4.5) to prevent microbial growth and enhance shelf life.
 - Brix Value Measurement: A refractometer determines the sugar concentration (°Brix), ensuring a balanced sweetness level and uniform energy content.
 - Viscosity Testing: A viscometer assesses the drink's thickness to ensure proper flow characteristics, which impact mouthfeel and consumer acceptance.

- Turbidity Analysis: A turbidity meter evaluates the clarity of the drink, ensuring proper filtration and removal of solid particles for a visually appealing product.
- Nutritional and Bioactive Compound Analysis
 - Vitamin and Mineral Content: The levels of vitamin C (from lemon), iron, calcium, and antioxidants (from Moringa and Ginger) are analyzed using UV-Visible Spectrophotometry and High-Performance Liquid Chromatography (HPLC).
 - Antioxidant Activity: A DPPH (2,2-diphenyl-1-picrylhydrazyl) assay or FRAP (Ferric Reducing Antioxidant Power) test determines the free radical scavenging activity, confirming the drink's health benefits.
 - Flavonoid and Polyphenol Content: The presence of bioactive compounds such as quercetin, catechins, and phenolic acids is analyzed to assess their role in anti-inflammatory and immune-boosting effects.
- Microbiological Testing
 - Total Plate Count (TPC): Determines the presence of bacteria and fungi to ensure the product is free from microbial contamination.
 - Yeast and Mold Test: Confirms that the drink does not contain harmful fungi that could affect safety and shelf life.
 - Pathogen Testing: Tests for E. coli, Salmonella, and Staphylococcus aureus to ensure the drink is free from harmful bacteria.

Packaging and Storage

The packaging and storage of the herbal energy drink play a crucial role in maintaining its quality, safety, shelf life, and consumer appeal. Proper packaging ensures protection from contamination, light, oxygen, and moisture, while effective storage conditions help preserve the nutritional, physicochemical, and sensory properties of the product. The selection of packaging materials, filling methods, labeling, and storage conditions is essential for maintaining product stability and compliance with regulatory guidelines.

- Selection of Packaging Materials
 - Glass Bottles: Preferred for premium herbal beverages as they are non-reactive, UV-resistant, and help maintain freshness. However, they are heavier and more fragile.
 - PET (Polyethylene Terephthalate) Bottles: Lightweight, durable, and resistant to breakage, making them a cost-effective option. PET bottles with UV barriers are used to prevent light degradation of bioactive compounds.
- Packaging Process
 - Before filling, bottles, cans, or pouches undergo sterilization using UV radiation, hot water rinsing, or chemical disinfection to eliminate microbial contamination.
 - The herbal energy drink is filtered and cooled before filling to prevent heat-induced degradation of bioactive compounds.

- Aseptic filling techniques are used to maintain sterility and prevent microbial contamination.
- Sealing is done using hermetic caps, screw tops, or heat-sealed laminates, ensuring air-tight closure to prevent oxidation and spoilage.
- Labels include product name, ingredient list, nutritional information, expiry date, batch number, storage instructions, and regulatory approvals.
- Tamper-evident seals are used to ensure product safety and consumer trust.
- **Storage Conditions**
- **Temperature Control:** The drink should be stored in a cool, dry place (5–25°C) to prevent microbial growth and degradation of nutrients.
- **Protection from Light:** UV light can degrade vitamin C and antioxidants, so packaging materials with UV barriers are recommended.
- **Humidity and Moisture Control:** Excess moisture can promote microbial contamination and affect packaging integrity. Dehumidified storage rooms help maintain product quality.

Stability and Shelf-Life Studies

Stability and shelf-life studies ensure the herbal energy drink retains its quality, safety, and nutritional value over time. Testing involves monitoring pH, color, taste, aroma, viscosity, and microbial safety under controlled temperature, humidity, and light conditions. Bioactive compounds such as antioxidants and vitamin C are analyzed to assess degradation.

MATERIAL AND EQUIPMENT

The development of a herbal energy drink using Moringa and Ginger requires proper selection, cleaning, and preparation of ingredients to ensure the best quality and health benefits.

Collection of Raw Materials

- **Moringa Leaves:**
 - Fresh or dried Moringa leaves are used.
 - They should be clean, free from dust, and grown without pesticides.
- **Ginger Root:**
 - Fresh ginger is chosen based on its firmness and strong aroma.
 - It should be free from dirt and mold.
- **Lemon:**
 - Fresh lemons are preferred for their tangy flavor and vitamin C.
 - They should be washed properly before use.
- **Honey:**
 - Natural, pure honey is used as a sweetener.
 - It should be free from artificial additives.

- Water:
 - Clean, filtered, or boiled water is used to maintain hygiene and purity.

Preparation of Raw Materials

- Moringa Leaves:
 - Washing: Fresh leaves are washed under clean water to remove dust.
 - Drying: If dried leaves are needed, they are left to dry in the shade for 2–3 days.
 - Grinding: Dried leaves are ground into a fine powder and stored in a dry place.
- Ginger Root:
 - Washing & Peeling: The ginger is cleaned properly and peeled.
 - Slicing or Grating: It is cut into small pieces or grated for better infusion.
 - Drying (optional): If dried ginger is required, it is left to dry for 3–5 days.
 - Storage: Fresh or dried ginger is stored in an airtight container.
- Lemon Juice:
 - Washing & Cutting: Lemons are washed and cut into halves.
 - Juicing: The juice is extracted and kept fresh for use.
- Honey:
 - Honey is stored properly to retain its natural sweetness and health benefits.
- Water Preparation:
 - Clean water is used for making the drink, either at room temperature or boiled.

Equipment

- Analytical Balance:

An analytical balance is essential for accurately weighing ingredients during formulation. Precision in measuring small quantities of plant extracts like Moringa and Ginger ensures the correct dosage, consistency, and effectiveness of the final product.

- pH Meter:

The pH meter measures the acidity or alkalinity of the herbal drink. Maintaining an optimal pH is crucial for taste, stability, and preventing microbial growth, ensuring both safety and consumer satisfaction.

- Refractometer:

A refractometer is used to measure the Brix value (sugar content) of the drink. This helps in evaluating sweetness levels and maintaining consistent taste and energy-boosting properties in each batch.

- UV-Visible Spectrophotometer:

This instrument helps in analyzing the presence and concentration of phytochemicals and antioxidants in the drink. It plays a critical role in standardizing the nutritional and medicinal value of the herbal ingredients.

- Viscometer:

The viscometer measures the viscosity (thickness) of the drink. It ensures the product has an appealing mouthfeel and is neither too thick nor too watery, maintaining consumer preference.

- Turbidity Meter:

A turbidity meter evaluates the clarity of the herbal drink. It helps in detecting any suspended particles or cloudiness, ensuring visual appeal and product stability.

- Microbiological Testing Kit:

This kit is used to test the presence of harmful bacteria, yeasts, or molds in the drink. Ensuring microbiological safety is vital for extending shelf life and meeting regulatory standards.

- Hot Air Oven:

The hot air oven is used for drying glassware, ingredients, or for stability testing under high temperatures. It ensures components used in formulation are sterile and moisture-free.

- Vacuum Dryer:

A vacuum dryer helps in drying Moringa and Ginger extracts at low temperatures to preserve their heat-sensitive nutrients and bioactive compounds, maintaining the efficacy of the drink.

- Autoclave/Sterilizer:

The autoclave sterilizes equipment and ingredients using pressurized steam. This is crucial in preventing contamination and ensuring the overall hygiene and safety of the production process.[14]

FORMULATION AND DEVELOPMENT

The formulation and development of an herbal energy drink using Moringa and Ginger involve a structured approach to ensure optimal nutritional content, bioactive compound retention, stability, and consumer acceptability. This process includes careful ingredient selection, precise formulation, and scientific evaluation to develop a safe, palatable, and effective herbal beverage.

The formulation and development of a herbal energy drink using Moringa and Ginger involve a scientific approach to ensure the product is nutritionally beneficial, stable, and safe for consumption. The process begins

with the selection of high-quality ingredients, including fresh or dried Moringa leaves, Ginger root, lemon juice, honey, and preservatives such as sodium benzoate. These ingredients are carefully processed to retain their bioactive compounds, ensuring maximum health benefits. The extraction process involves infusing Moringa and Ginger in hot water, followed by filtration and purification to remove solid residues while preserving essential nutrients. The filtrate is then blended with other ingredients, ensuring a homogeneous mixture with balanced flavor and texture.

Once the formulation is prepared, it undergoes quality control tests to check pH, viscosity, turbidity, microbial safety, and total soluble solids (Brix value) for consistency and safety.

Ingredients

The formulation involves optimizing ingredient concentrations to ensure nutritional balance, palatability, and stability while maintaining a natural and refreshing taste.

- A. Fresh or dried Moringa leaves – 1 cup (or 2 tablespoons of powdered Moringa)
- B. Fresh Ginger root – 2 tablespoons (grated or sliced)
- C. Lemon juice – 2 tablespoons (for flavor and vitamin C)
- D. Honey – 1 tablespoon (natural sweetener)
- E. Sodium Benzoate – 0.1g Effective in acidic environments (pH < 4.5).
- F. Water – 1 liter

Formulation process

Selection of Ingredients – Choosing high-quality Moringa, Ginger, and other components.

Collection and Preparation of Raw Materials – Washing, drying, and processing ingredients.

Extraction of Bioactive Compounds – Infusing Moringa and Ginger in hot water.

Filtration and Purification – Removing solid residues to obtain a clear extract.

Blending and Mixing – Adding lemon juice, honey, and preservatives while stirring.

Quality Control and Standardization – Checking pH, viscosity, Brix value, and microbial safety

Packaging and Storage – Bottling in sterilized containers and storing under optimal conditions.

Stability and Shelf-Life Testing – Assessing nutritional, microbial, and sensory stability.



Final Product Standardization – Optimizing the formulation for consumer acceptance.

Development

The development of a herbal energy drink using Moringa and Ginger involves a systematic approach to create a nutritious, refreshing, and stable beverage. The process begins with extensive research and selection of ingredients based on their nutritional and medicinal properties. Moringa is chosen for its rich antioxidant, vitamin, and mineral content, while Ginger is included for its anti-inflammatory, digestive, and energizing properties. The development phase focuses on optimizing ingredient proportions, extraction techniques, and blending methods to ensure a well-balanced formulation.

During the development, key factors such as taste, texture, solubility, and stability are evaluated through multiple trials and adjustments. The product undergoes quality assessments, including pH balancing, microbial safety testing, and sensory evaluations, to ensure it meets consumer acceptability and regulatory standards. Additionally, shelf-life studies are conducted to determine the best storage conditions and packaging materials for maintaining freshness.

- **Filtration and Purification** : Removing solid residues to obtain a clear, nutrient-rich extract.
- **Microbial and Nutritional Analysis** :Ensuring the product is free from harmful bacteria and retains essential nutrients.
- **Sensory Evaluation** :Testing taste, aroma, texture, and appearance for consumer acceptability.
- **Packaging and Labeling** : Using sterilized containers to maintain freshness and prevent contamination.
- **Final Product Standardization** : Refining the formulation through multiple trials before commercial production.



Fig(4):- Purification Process Of Energy Drink

Formulation table

Is the Formulation Table for the Development and Formulation of Herbal Energy Drinks Here Using Moringa and Ginger, including Quantity Given and Quantity Taken for three batches.

Ingredients	Quantity Given	Batch 1 (B1) (Quantity Taken)	Batch 2 (B2) (Quantity Taken)	Batch 3 (B3) (Quantity Taken)
Moringa Leaves (Powdered)	10g	2g	2.5g	3g
Ginger Extract	10g	1.5g	2g	2.5g
Lemon Juice	50mL	2mL	2.5mL	3mL
Honey (Sweetener)	100mL	5mL	7mL	10mL
Sodium Benzoate (Preservative)	1g	0.05g	0.05g	0.05g
Water	500mL	100mL	100mL	100mL

METHOD AND EVOLUTION PARAMETER

The formulation of an herbal energy drink using Moringa and Ginger follows a structured process to ensure nutritional value, taste, stability, and safety. The method is classified into small-scale (laboratory or home-based) and large-scale (commercial) production.

The development of herbal energy drinks has evolved over time based on scientific research, consumer preferences, and technological advancements.

Methods

- Small-Scale Formulation (Laboratory or Household Level)
 - Ingredient Preparation : Manually washing, drying, and grinding Moringa leaves; peeling and slicing Ginger.
 - Extraction : Boiling or cold infusion of Moringa and Ginger in water using a basic stovetop or water bath.
 - Filtration :Using muslin cloth, coffee filters, or fine mesh strainers to remove residues.
 - Blending – Manual or hand-mixer blending of lemon juice, honey, and preservatives.
 - Quality Control : Basic pH testing and taste evaluation for stability and consumer preference.
 - Packaging : Stored in glass bottles, plastic containers, or food-grade pouches.
 - Storage : Refrigeration or cool storage to maintain freshness for a short duration (3–7 days).
- Large-Scale Formulation (Commercial/Industrial Level)

- Extraction : Performed using high-pressure steam extraction or industrial infusion systems.
- Filtration : Automated vacuum or pressure filtration systems for large batches.
- Blending & Homogenization : High-speed industrial mixers and homogenizers for uniform consistency.
- Packaging : Automated bottling, labeling, and sealing machines for extended shelf life.
- Storage & Distribution : Cold storage, warehousing, and logistics management for wider market reach.



Fig(5):- Moringa and Ginger Energy Drink Making Process

Evolution parameter

The evaluation of herbal energy drinks focuses on assessing their sensory, physicochemical, microbiological, and stability parameters to ensure quality, safety, and consumer acceptance.

- Organoleptic Evaluation
 - Appearance & Color : Assessed for clarity, uniformity, and stable greenish tint from Moringa.
 - Taste & Flavor : Balanced herbal taste with mild bitterness from Moringa and a warm, spicy note from Ginger.
 - Aroma & Odor : Pleasant herbal fragrance with a fresh and slightly spicy undertone.
 - Texture & Mouthfeel : Smooth consistency, moderate viscosity, minimal suspended particles.
 - Aftertaste : Refreshing, mild herbal aftertaste without excessive bitterness.
 - Overall Acceptability : Evaluated based on combined sensory attributes for consumer preference.
- pH Determination
 - Purpose : Ensures the drink's acidity or alkalinity is within the optimal range for stability and safety.
 - Calibration : The pH meter is calibrated using standard buffer solutions (pH 4.0, 7.0, and 9.0).

- Measurement : The electrode is dipped into the sample, and the pH reading is recorded.
- Preferred pH Range : Typically between 3.5 to 5.5 to prevent microbial growth and enhance stability.
- Total Soluble Solids (°Brix Test)
 - Purpose : Measures the concentration of dissolved solids, primarily sugars, to determine sweetness and consistency.
 - Instrument Used : A refractometer is used to measure the °Brix value of the herbal energy drink.
 - Preferred Range : Typically 8–15°Brix, ensuring balanced sweetness and energy content.
- Turbidity Test
 - Purpose : Measures the fluid's resistance to flow, indicating thickness and mouthfeel.
 - Method : Utilizes instruments like capillary or rotational viscometers to assess viscosity.
 - Preferred Range (Herbal Drinks): <10 NTU (for clear beverages) / 10–50 NTU (for acceptable natural turbidity in herbal formulations)
- Microbial Load Test
 - Purpose : Checks for bacterial, yeast, and mold contamination to ensure product safety.
 - Method : Uses Total Plate Count (TPC), Yeast & Mold Count, and Pathogen Testing.
 - Preferred Range (Safe Product): TVC ≤ 1000 : Yeast & Mold ≤ 100 : Pathogens = 0
- Antioxidant Activity Test
 - Purpose : Assesses the drink's ability to neutralize free radicals.
 - Method : Uses DPPH, ABTS, and FRAP assays with spectrophotometric analysis.
 - Preferred range (Moringa:Ginger Antioxidants): 2:1 (for balanced flavor and functional benefits)
- Nutritional Analysis
 - Purpose : Evaluates essential nutrients like vitamins, minerals, carbohydrates, and proteins.
 - Method : Uses proximate analysis, spectrophotometry, and chromatography for nutrient quantification.
 - Preferred Range : Carbohydrates: 7–15 g (sugars 5–12 g), Protein: 0.5–2 g, Fats: <0.5 g, Dietary Fiber: 0.5–1.5 g, Vitamin C: 2–15 mg, Iron: 0.1–0.5 mg, Calcium: 2–20 mg
- Shelf-Life Stability
 - Purpose : Determines the drink's stability over time by analyzing changes in quality, safety, and efficacy.
 - Method : Evaluates pH, color, taste, microbial load, and antioxidant retention under different storage conditions.
 - Preferred Range : 6–12 months at ambient temperature (25–30°C) with no significant changes in taste, color, turbidity, microbial load, or antioxidant activity.
- Foam Stability
 - Purpose : Measures the stability and retention of foam in the herbal energy drink.
 - Method : Foam height is recorded after shaking, and the collapse rate is monitored over time.

- Preferred Range :Foam volume retention $\geq 50\%$ after 5 minutes for herbal energy drinks to ensure appealing texture and sensory quality.
- Heavy Metal Analysis
 - Purpose : Detects toxic heavy metals (lead, arsenic, mercury, cadmium) to ensure safety.
 - Method : Uses Atomic Absorption Spectroscopy (AAS) or Inductively Coupled Plasma (ICP) for precise quantification.
 - Preferred Range : Lead <0.01 mg/L, Arsenic <0.01 mg/L, Mercury <0.001 mg/L, Cadmium <0.003 mg/L to ensure safety and regulatory compliance.
- Preservative Efficacy Test
 - Purpose : Evaluates the effectiveness of preservatives in preventing microbial growth.
 - Method : Involves inoculating the drink with microbes and monitoring microbial reduction over time.
 - Preferred Range : $\geq 99\%$ reduction of microbial load within 14 days and no regrowth up to 28 days to ensure effective microbial preservation.
- Consumer Acceptability Test
 - Purpose : Assesses consumer preferences based on taste, aroma, appearance, and overall satisfaction.
 - Method : Conducts sensory evaluation through a panel test or survey using a structured questionnaire.
 - Preferred Range : $\geq 80\%$ overall acceptability on a 9-point hedonic scale for taste, aroma, color, and mouthfeel to ensure product likability.[20]



Fig(6):- ph determination

EXPECTED OUTCOME

The expected outcome of developing and formulating herbal energy drinks using Moringa and Ginger includes a nutrient-rich, refreshing beverage with enhanced health benefits. The drink is anticipated to have high antioxidant activity, providing immune-boosting, anti-inflammatory, and energy-enhancing properties. It is expected to maintain good stability, acceptable sensory characteristics, and an extended shelf-life while being free from harmful microbial contamination. Additionally, the formulation aims to meet consumer acceptability standards, ensuring a safe, effective, and marketable herbal energy drink.

- **Enhanced Nutritional Profile:** The drink will provide essential vitamins, minerals, and antioxidants derived from Moringa and Ginger.
- **Natural Energy Boost:** It is expected to offer a natural source of energy without the crash associated with synthetic energy drinks.
- **Improved Digestive Health:** Ginger's known digestive properties may help soothe the stomach and aid in digestion.
- **Antioxidant Protection:** The formulation may help combat oxidative stress due to the rich antioxidant content of Moringa and Ginger.
- **Immunity Support:** Regular consumption could strengthen the immune system through bioactive compounds like quercetin and gingerol.
- **Reduced Side Effects:** Being plant-based, the drink is expected to have fewer side effects compared to caffeine-heavy synthetic options.
- **Appealing Flavor Profile:** A balanced combination of Moringa and Ginger may result in a pleasant, refreshing taste.
- **Suitable for All Ages:** Formulated without harmful additives, it may be safe and beneficial for both younger and older consumers.
- **Extended Shelf Life:** With proper formulation and pasteurization, the drink could maintain stability and efficacy over time.
- **Eco-Friendly Alternative:** Utilizing natural ingredients supports sustainable sourcing and reduces the environmental impact.
- **Market Demand Fulfillment:** The drink may meet the rising consumer demand for herbal and plant-based functional beverages.
- **Convenient Nutritional Intake:** Offers a practical way to consume Moringa and Ginger daily for health-conscious individuals.
- **Supports Weight Management:** May help in metabolism regulation and fat digestion, aiding weight-conscious consumers.
- **Stress Reduction Benefits:** Ginger's adaptogenic properties may help reduce stress and fatigue.

- Functional Beverage Innovation: Adds value to the growing functional drink market with a unique and health-focused formulation.[21]

HEALTH BENEFITS

The herbal energy drink formulated with Moringa and Ginger provides numerous health benefits due to its rich nutritional composition and bioactive compounds. The combination of these two potent herbal ingredients results in a natural, refreshing, and health-boosting beverage that promotes overall well-being. Below are the key health benefits in detail

- Boosts immunity by providing a rich source of antioxidants, vitamins, and minerals that help strengthen the body's defense system.
- Enhances energy levels naturally through bioactive compounds in Moringa and Ginger, without relying on artificial stimulants or caffeine.
- Supports digestion by promoting the release of digestive enzymes, reducing bloating, and easing stomach discomfort with ginger's anti-inflammatory effects.
- Aids in weight management by increasing metabolism, promoting fat breakdown, and supporting a balanced diet for maintaining a healthy body weight.
- Improves cardiovascular health by reducing bad cholesterol (LDL), regulating blood pressure, and promoting heart function with bioactive compounds.
- Regulates blood sugar levels by improving insulin sensitivity and reducing post-meal sugar spikes, making it beneficial for diabetics.
- Provides anti-inflammatory benefits by reducing oxidative stress, minimizing joint pain, and alleviating symptoms of arthritis and other inflammatory conditions.
- Detoxifies the body by eliminating harmful toxins, cleansing the liver, and supporting kidney function for better overall detoxification.
- Enhances cognitive function by improving brain activity, boosting memory, and reducing the risk of neurodegenerative diseases like Alzheimer's.
- Supports healthy skin by nourishing cells with essential vitamins, reducing acne, and promoting a youthful glow with natural antioxidants.
- Reduces fatigue and promotes stamina by replenishing essential nutrients, improving oxygen circulation, and increasing overall endurance.
- Maintains gut health by promoting the growth of beneficial gut bacteria, improving digestion, and preventing issues like constipation and bloating.
- Promotes hydration and electrolyte balance by restoring lost minerals, keeping the body hydrated, and preventing dehydration-related fatigue.

- Helps in stress reduction by reducing cortisol levels, promoting relaxation, and supporting better sleep with calming herbal properties.
- Improves respiratory health by reducing mucus buildup, clearing airways, and helping with conditions like asthma and bronchitis.
- Enhances liver function by protecting liver cells from damage, promoting bile production, and aiding in the breakdown of toxins.
- Strengthens bones by supplying essential minerals like calcium, magnesium, and phosphorus to maintain bone density and strength.
- Supports hormonal balance by regulating endocrine function, improving reproductive health, and reducing symptoms of hormonal imbalances.
- Protects against infections by exhibiting antimicrobial properties, reducing the risk of bacterial and viral infections, and boosting immunity.
- Improves circulation by promoting better blood flow, reducing the risk of blood clots, and enhancing oxygen supply to organs and tissues.[22][23][24][25]

SCOPE AND LIMITATIONS

The development of a herbal energy drink using Moringa and Ginger aims to provide a natural, nutrient-rich alternative to synthetic energy drinks. It enhances immunity, metabolism, and overall well-being while being eco-friendly and sustainable. However, challenges include shelf-life stability, preservation, and taste acceptability. Large-scale production may require improved processing, regulatory approvals, and consumer adaptation.

Scope

- Focuses on utilizing natural ingredients like Moringa and Ginger for energy-boosting and health benefits.
- Provides an alternative to synthetic energy drinks with added nutritional and medicinal properties.
- Enhances immunity, metabolism, digestion, and cardiovascular health through bioactive compounds.
- Can be formulated for small-scale and large-scale production with natural preservatives.
- Potential for commercialization as a functional health drink in the nutraceutical and wellness industry.
- Suitable for various consumer groups, including athletes, working professionals, and health-conscious individuals.
- Offers potential for further research on ingredient optimization, sensory evaluation, and consumer acceptability.

Limitations

- Shelf-life stability may be lower compared to commercial synthetic energy drinks.
- Requires proper storage conditions to prevent microbial growth and degradation of nutrients.
- The taste and sensory profile may not be appealing to all consumers without additional flavoring agents.
- Availability and cost of fresh Moringa and Ginger may impact large-scale production.
- Preservation challenges due to the absence of strong synthetic preservatives.
- Regulatory approvals and safety testing are necessary for commercial market acceptance.
- Variations in ingredient quality and processing methods may affect final product consistency.
- Requires further scientific validation of long-term health benefits and consumer acceptability.
- Limited awareness and market penetration compared to mainstream energy drinks.
- Packaging constraints to ensure product stability and prevent contamination.[26][27][28]

Market trend and consumer preferences

- Growing Demand for Natural Beverages: Consumers are shifting towards plant-based, herbal, and organic drinks as healthier alternatives to synthetic energy drinks.
- Rise in Functional Beverages: Increasing preference for drinks that offer added health benefits, such as immunity boosting, digestion support, and antioxidant properties.
- Preference for Clean Label Products: Consumers favor products with minimal additives, preservatives, and artificial ingredients, making herbal energy drinks highly desirable.
- Increased Awareness of Herbal Ingredients: Moringa and Ginger are widely recognized for their nutritional and medicinal benefits, attracting health-conscious consumers.
- Sustainability and Eco-Friendliness: Demand for sustainable, biodegradable, and recyclable packaging influences purchasing decisions in the beverage market.
- Growing Sports and Fitness Industry Influence: Athletes and fitness enthusiasts seek natural energy drinks to improve endurance, hydration, and muscle recovery.
- Expansion of Organic and Herbal Beverage Market: The global herbal and functional drink market is expanding due to rising health concerns and lifestyle changes.
- Preference for Low-Sugar and Natural Sweeteners: Consumers are moving away from high-sugar drinks, preferring naturally sweetened beverages with honey or stevia.
- Rise in Personalized Nutrition: Consumers look for customized drinks catering to specific health needs, such as weight management, detoxification, and energy boost.

- Impact of E-Commerce and Online Sales: The availability of herbal energy drinks on digital platforms makes them more accessible, boosting market growth.
- Regulatory and Labeling Compliance: Increasing government regulations demand transparency in ingredient sourcing, safety testing, and nutritional claims.
- Consumer Interest in Exotic and Unique Flavors: Unique herbal blends, including Moringa and Ginger, attract consumers seeking new and refreshing beverage options.[29][30]

Result And Discussion

Result

Sr. No	Parameter	Batch 1	Batch 2	Batch 3
1	pH	4.2	4.5	4.3
2	Viscosity (cP)	18.5	19.5	18.8
3	Color (Absorbance)	0.65	0.70	0.68
4	Taste (Sensory Score)	7.5	8.2	8.0
5	Aroma(Sensory Score)	7.0	8.0	7.8
6	Microbial Load (CFU/mL)	100	80	90
7	Nutrient Content (mg/100 mL)	55.3	60.1	58.7
8	Antioxidant Activity (%)	72.5	78.2	75.6
9	Sedimentation (mL)	0.5	0.3	0.4
10	Shelf Stability (days)	30	45	40

Discussion

The formulation of an herbal energy drink using Moringa and Ginger successfully combined the nutritional richness and functional properties of both botanicals. Moringa oleifera, known for its high content of essential vitamins, minerals, and powerful antioxidants, provided a strong nutritional backbone to the formulation. Its bioactive compounds such as flavonoids, polyphenols, and carotenoids contributed significantly to the antioxidant activity of the drink, enhancing its potential to combat oxidative stress. Ginger (Zingiber officinale) not only complemented Moringa's nutrient profile but also enhanced the drink's health benefits by adding strong anti-inflammatory and digestive properties. Additionally, Ginger improved the sensory profile

by offering a pleasant spicy kick, which masked the slight bitterness of Moringa, resulting in higher consumer acceptability.

The synergistic effect of Moringa and Ginger ensured a natural energy boost without the side effects typically associated with synthetic energy drinks, such as crashes, dehydration, or palpitations. The drink's stability over time, confirmed by quality control tests, indicated that natural preservatives within the plant extracts were effective in maintaining product quality. The success of this formulation aligns with current market trends favoring clean-label, organic, and plant-based functional beverages. Thus, the study demonstrates that the Moringa-Ginger herbal energy drink has great potential not only for health-conscious consumers but also for the broader functional beverage industry seeking innovative, natural, and effective alternatives to conventional energy drinks.

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