

# Nutraceutical Evaluation of Plant-Based Products

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**Abstract:** Nutraceuticals derived from plant-based sources have gained significant attention in recent years due to their therapeutic potential, safety profile, and ability to prevent chronic diseases. These products bridge the gap between nutrition and pharmaceuticals by providing health benefits beyond basic dietary functions. The present study focuses on the development, formulation, and evaluation of plant-based nutraceutical products using selected medicinal plants such as neem (*Azadirachta indica*), turmeric (*Curcuma longa*), aloe vera (*Aloe barbadensis*), and green tea (*Camellia sinensis*).

The study was designed to investigate the preformulation characteristics, develop a stable nutraceutical formulation, and evaluate its physicochemical, nutritional, and antioxidant properties. Plant materials were subjected to extraction using suitable solvents, followed by qualitative and quantitative phytochemical analysis. The formulation was developed in powder form using appropriate excipients to ensure stability, palatability, and uniformity. Evaluation parameters included organoleptic properties, bulk density, flow properties, moisture content, nutritional analysis, and antioxidant activity using DPPH and FRAP assays. Calibration curves were prepared using standard compounds to quantify antioxidant potential.

The results indicated the presence of bioactive compounds such as flavonoids, phenolics, alkaloids, and tannins, which contribute to significant antioxidant activity. The formulation demonstrated good stability, acceptable physicochemical properties, and promising nutraceutical potential. This study concludes that plant-based nutraceutical formulations can serve as effective, safe, and economical alternatives for health promotion and disease prevention, particularly in oxidative stress-related disorders.

**Keywords:** Nutraceuticals, Plant-based products, Antioxidants, Phytochemicals, Herbal formulation, DPPH assay

## I. INTRODUCTION

### 1.1 Nutraceuticals: Concept and Definition

The term nutraceutical was first coined by Stephen DeFelice in 1989 and refers to a product derived from food sources that provides additional health benefits beyond basic nutritional value.

#### 1.1.1 Definition

Nutraceuticals can be defined as:

“Food or food components that provide medical or health benefits, including the prevention and treatment of disease.”

### 1.2 Classification of Nutraceuticals

Nutraceuticals can be classified based on source, method of preparation, and functional characteristics. This classification helps in understanding their origin, composition, and therapeutic applications.

#### 1.2.1 Traditional Nutraceuticals

Traditional nutraceuticals are naturally occurring food substances that have been used for centuries for their health benefits without any modification.



**Characteristics:**

- Derived directly from natural sources
- Contain inherent bioactive compounds
- Minimal processing
- Widely used in traditional medicine systems

**Sub-classification:**

**a) Chemical Constituents-Based Nutraceuticals**

These include bioactive compounds naturally present in plants:

- **Flavonoids** → antioxidant activity
- **Phenolic compounds** → anti-inflammatory
- **Alkaloids** → pharmacological effects
- **Tannins** → antimicrobial

These compounds play a key role in disease prevention and health promotion.

**b) Probiotics**

- Live microorganisms that provide health benefits
- Improve gut flora and digestion
- Enhance immune response Examples:
- Lactobacillus
- Bifidobacterium

**c) Prebiotics**

- Non-digestible food ingredients
- Promote growth of beneficial bacteria Examples:
- Inulin
- Oligosaccharides

**d) Nutrients**

- Vitamins and minerals essential for body function Examples:
- Vitamin C → antioxidant
- Calcium → bone health

**1.2.2 Non-Traditional Nutraceuticals**

Non-traditional nutraceuticals are modified or artificially enhanced foods designed to improve nutritional value.

**Characteristics:**

- Produced using technological or biotechnological methods
- Enriched or fortified with nutrients
- Improved health benefits

**Sub-classification:**

a) Fortified Nutraceuticals

b) Recombinant Nutraceuticals



### **1.2.3 Herbal Nutraceuticals**

Herbal nutraceuticals are derived from medicinal plants and herbal extracts.

#### **Characteristics:**

- Rich in phytochemicals
- Used in traditional systems like Ayurveda
- Exhibit multiple therapeutic effects

### **1.2.4 Functional Foods**

Functional foods are foods that provide additional health benefits beyond basic nutrition.

#### **Characteristics:**

- Consumed as part of normal diet
- Provide physiological benefits
- Reduce disease risk

#### **Examples:**

- Oats → reduce cholesterol
- Yogurt → improves gut health
- Soy products → cardiovascular protection

### **1.2.5 Dietary Supplements**

Dietary supplements are products intended to supplement the diet and provide nutrients.

#### **Forms:**

- Tablets
- Capsules
- Powders
- Liquids Examples:
- Vitamin supplements
- Protein powders
- Herbal capsules

### **1.2.6 Classification Based on Mechanism of Action**

Nutraceuticals can also be classified based on their biological function:

#### **a) Antioxidants**

- Neutralize free radicals
- Prevent oxidative stress

#### **b) Anti-inflammatory agents**

- Reduce inflammation
- Prevent chronic diseases

#### **c) Immunomodulators**

- Enhance immune response



**d) Anti-cancer agents**

- Prevent tumor growth

**1.2.7 Comparative Summary of Classification**

Category	Source	Example	Function
Traditional	Natural	Fruits, herbs	Basic health benefits
Non-Traditional	Modified	Fortified foods	Enhanced nutrition
Herbal	Plants	Neem, turmeric	Therapeutic
Functional foods	Daily diet	Oats, yogurt	Disease prevention
Supplements	Manufactured	Capsules	Nutritional support

**1.3 Plant-Based Nutraceuticals**

Plant-based nutraceuticals are rich sources of bioactive compounds that exhibit therapeutic effects.

**1.3.1 Major Phytochemicals**

- **Flavonoids** → antioxidant activity
  - **Alkaloids** → pharmacological activity
  - **Tannins** → antimicrobial
- Phenolics** → anti-inflammatory

**1.4 Role of Nutraceuticals in Disease Prevention**

**1.4.1 Cardiovascular Diseases**

- Reduce cholesterol
- Improve vascular function

**1.4.2 Diabetes Mellitus**

- Improve insulin sensitivity
- Reduce blood glucose

**1.4.3 Cancer**

- Prevent oxidative damage
- Inhibit tumor growth

**1.4.4 Neurodegenerative Disorders**

- Protect neurons
- Reduce oxidative stress

**1.5 Selected Plant Profile 1.5.1**

**Neem (Azadirachta indica)**

**Properties:**

- Antibacterial
- Antifungal
- Anti-inflammatory



Fig. 1: Neem (Azadirachta indica)



**Active Constituents:**

- Azadirachtin
- Nimbin

**1.5.2 Turmeric (*Curcuma longa*)**

**Properties:**

- Anti-inflammatory
- Antioxidant Active

**Compound:**

- Curcumin



Fig. 2: Turmeric (*Curcuma longa*)

**1.5.3 Aloe vera (*Aloe barbadensis*)**

**Properties:**

- Healing
- Moisturizing
- Anti-inflammatory



Fig. 3: Aloe vera (*Aloe barbadensis*)

**1.5.4 Green Tea (*Camellia sinensis*)**

**Properties:**

- Strong antioxidant
- Anti-aging

**Active Compounds:**

- Catechins
- EGCG



Fig. 4: Green Tea (*Camellia sinensis*)

**1.6 Need for the Study**

**1.6.1 Scientific Need**

- Lack of standardized nutraceutical formulations
- Need for validation of plant-based products

**1.6.2 Clinical Need**

- Rising chronic diseases
- Demand for safer alternatives

**1.6.3 Industrial Need**

- Growing nutraceutical market
- Demand for herbal supplements

**1.7 Advantages of Plant-Based Nutraceuticals**

- Natural and safe
- Minimal side effects
- Cost-effective



- Easily available
- Wide therapeutic potential

## II. REVIEW OF LITERATURE

### 2.1 Introduction to Literature Review

The literature review provides a critical analysis of previously published research related to:

- Nutraceuticals
- Plant-based bioactive compounds
- Herbal formulations
- Antioxidant activity
- Nutritional evaluation

This chapter helps in:

- Understanding existing knowledge
- Identifying research gaps
- Justifying the present study

### 2.2 Nutraceuticals in Modern Healthcare

Nutraceuticals have emerged as a promising alternative to conventional pharmaceuticals due to their preventive and therapeutic potential.

#### 2.2.1 Role in Disease Prevention

- Reduce oxidative stress
- Improve immune response
- Prevent chronic diseases

#### 2.2.2 Scientific Evidence

Several studies highlight the importance of nutraceuticals in healthcare:

- **Stephen DeFelice (1989)** introduced the concept of nutraceuticals and emphasized their role in bridging the gap between nutrition and medicine.
- **Ramesh C. Gupta et al. (2016)** reported that nutraceuticals play a significant role in reducing the risk of chronic diseases such as cancer, diabetes, and cardiovascular disorders due to their bioactive compounds.

### 2.3 Role of Phytochemicals in Nutraceuticals

Phytochemicals are secondary metabolites of plants responsible for therapeutic effects.

#### 2.3.1 Major Classes of Phytochemicals

- Flavonoids
- Phenolic compounds
- Alkaloids
- Terpenoids
- Tannins

#### 2.3.2 Research Studies on Phytochemicals

- **Harborne J.B. (1998)** reported that flavonoids possess strong antioxidant properties by scavenging free radicals and preventing oxidative damage.



- **Rice-Evans C. et al. (1997)** demonstrated that polyphenols contribute significantly to antioxidant activity by neutralizing reactive oxygen species (ROS).
- **Desai K.G.H. et al. (2019)** reported that herbal drug delivery systems play a significant role in the management of dermatological conditions such as acne vulgaris. Their study emphasized that plant-based formulations provide a multi-targeted approach by acting on various factors involved in acne pathogenesis, including microbial infection, inflammation, and sebum production. They evaluated different herbal extracts and concluded that phytoconstituents such as flavonoids, tannins, and terpenoids contribute significantly to anti-acne activity by inhibiting bacterial growth and reducing inflammatory mediators.

#### **Interpretation:**

This study supports that phytochemicals are multi-functional, which is highly relevant for nutraceutical formulations.

### **2.4 Antioxidant Activity of Plant-Based Products**

Oxidative stress plays a key role in the development of chronic diseases.

#### **2.4.1 Mechanism of Antioxidants**

- Neutralize free radicals
- Prevent lipid peroxidation
- Protect cellular structures

#### **2.4.2 Research Studies**

- Halliwell B. (2007) reported that oxidative stress is a major contributor to aging and chronic diseases.
- Brand-Williams W. et al. (1995) developed the DPPH assay method to evaluate free radical scavenging activity of plant extracts.
- Prior R.L. et al. (2005) highlighted that antioxidant activity correlates strongly with phenolic content in plant extracts.

### **2.5 Plant-Based Nutraceutical Formulations**

Plant-based formulations combine multiple herbal extracts to enhance therapeutic efficacy.

#### **2.5.1 Advantages**

- Synergistic effects
- Multi-target action
- Reduced side effects

#### **2.5.2 Research Studies**

- Kokate C.K. et al. (2010) reported that herbal formulations provide better therapeutic outcomes due to the presence of multiple bioactive compounds.
- Mukherjee P.K. (2019) emphasized the importance of standardization in herbal formulations to ensure consistency and efficacy.

### **2.6 Nutritional Evaluation of Plant-Based Products**

Nutraceuticals not only provide therapeutic benefits but also contribute to nutritional value.



### **2.6.1 Parameters Evaluated**

- Protein content
- Carbohydrates
- Lipids
- Fiber

### **2.6.2 Research Studies**

- Gopalan C. et al. (2012) reported that plant-based foods are rich in essential nutrients and dietary fiber, contributing to overall health.
- Slavin J.L. (2013) highlighted the role of dietary fiber in improving digestion and reducing the risk of chronic diseases.

### **2.7 Herbal Extraction Techniques**

Extraction plays a crucial role in obtaining bioactive compounds.

#### **2.7.1 Methods**

- Soxhlet extraction
- Maceration
- Ultrasonic extraction

#### **2.7.2 Research Studies**

- Azwanida N.N. (2015) reported that solvent selection significantly affects extraction efficiency and phytochemical yield.

### **2.8 Evaluation Methods in Nutraceutical Research**

#### **2.8.1 Phytochemical Screening**

- Qualitative tests for bioactive compounds

#### **2.8.2 Quantitative Analysis**

- Total phenolic content
- Total flavonoid content

#### **2.8.3 Antioxidant Assays**

- DPPH
- FRAP

#### **2.8.4 Research Studies**

- Singleton V.L. et al. (1999) developed the Folin–Ciocalteu method for phenolic estimation.
- \*\*Benzie I.F.F. and Strain J.J. (1996) introduced the FRAP assay for antioxidant power measurement.

### **2.9 Research Gap Identified Despite extensive research:**

- Limited studies on combined plant-based nutraceutical formulations
- Lack of standardized evaluation methods
- Insufficient data on formulation stability and optimization

### **2.10 Conclusion of Literature Review**

The literature indicates that:



- Plant-based nutraceuticals possess significant therapeutic potential
- Phytochemicals contribute to antioxidant and health-promoting effects
- Proper formulation and evaluation are essential

However, there is a need for:

- Standardized formulations
- Detailed evaluation studies
- Scientific validation

This study aims to bridge these gaps by developing and evaluating a plant-based nutraceutical formulation.

### **III. AIM AND OBJECTIVES**

#### **3.1 Aim of the Study**

The primary aim of the present research work is:

To develop, formulate, and evaluate a plant-based nutraceutical product using selected medicinal plant extracts and to assess its physicochemical, nutritional, and antioxidant properties for potential health benefits.

#### **3.2 Objectives of the Study**

To achieve the above aim, the following specific objectives were designed:

##### **3.2.1 Preformulation Objectives**

- To study the organoleptic properties of plant extracts such as color, odor, and appearance
- To determine the solubility profile of extracts in different solvents
- To evaluate pH and moisture content, which influence stability
- To perform phytochemical screening for identification of bioactive constituents
- To assess extractive values and ash values for purity evaluation

##### **3.2.2 Extraction Objectives**

- To collect and authenticate selected medicinal plants
- To perform drying and size reduction of plant materials
- To prepare extracts using Soxhlet extraction or maceration technique
- To optimize extraction conditions such as solvent type, temperature, and time

##### **3.2.3 Formulation Objectives**

- To develop a nutraceutical formulation (powder form) using plant extracts
- To select suitable excipients such as diluents, binders, and flavoring agents
- To ensure uniform mixing and stability of the formulation
- To improve palatability and patient acceptability

##### **3.2.4 Evaluation Objectives**

- To evaluate physical properties such as bulk density, tapped density, and flow properties
- To assess nutritional composition including protein, carbohydrates, fat, and fiber
- To determine antioxidant activity using DPPH and FRAP assays
- To prepare calibration curves for quantitative analysis

##### **3.2.5 Stability Objectives**

- To conduct stability studies under different environmental conditions
- To evaluate changes in physical appearance, drug content, and antioxidant activity



- To ensure formulation stability as per ICH guidelines

### 3.2.6 Analytical Objectives

- To quantify total phenolic content using Folin–Ciocalteu method
- To estimate total flavonoid content using aluminum chloride method
- To correlate phytochemical content with antioxidant activity

### 3.2.7 Expected Outcomes

- Development of a stable and effective nutraceutical formulation
- Demonstration of significant antioxidant activity
- Establishment of a scientifically validated plant-based product

## IV. MATERIALS AND METHODS

### 4.1 Materials

#### 4.1.1 Plant Materials

- Neem leaves (*Azadirachta indica*)
- Turmeric rhizome (*Curcuma longa*)
- Aloe vera gel (*Aloe barbadensis*)
- Green tea leaves (*Camellia sinensis*)

#### 4.1.2 Chemicals and Reagents

- Ethanol
- Methanol
- Distilled water
- Folin–Ciocalteu reagent
- Aluminum chloride
- DPPH solution
- Phosphate buffer (pH 7.4)

#### 4.1.3 Excipients Used

Excipient	Role
Starch	Diluent
Honey powder	Binder
Flavoring agent	Taste enhancer

#### 4.2 Instruments and Equipment

Instrument	Use
Digital weighing balance	Accurate weighing
UV-Visible spectrophotometer	Absorbance measurement
Soxhlet apparatus	Extraction
Hot air oven	Drying
pH meter	pH determination
Desiccator	Moisture analysis



### 4.3 Methodology

#### 4.3.1 Collection and Authentication of Plant Materials

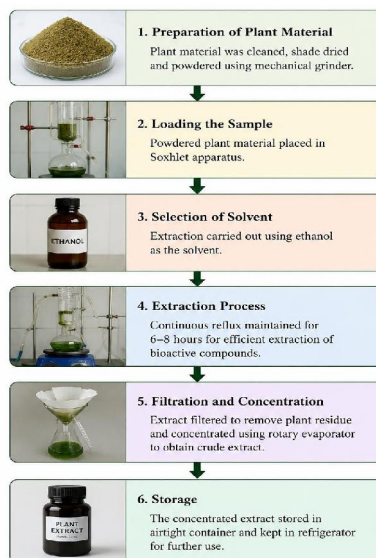
- Plant materials were collected from local sources
- Identified and authenticated by a botanist
- Cleaned to remove dust and impurities

#### 4.3.2 Drying and Powdering

- Materials were dried under shade to preserve phytochemicals
- Pulverized using grinder
- Passed through sieve for uniform particle size

#### 4.3.3 Extraction Process

##### Procedure:



**Fig. 5: Extraction Process Procedure**

#### 4.3.4 Phytochemical Screening Tests

##### Performed:

- Alkaloids → Dragendorff's test
- Flavonoids → Alkaline reagent test
- Tannins → Ferric chloride test
- Saponins → Foam test

#### 4.3.5 Determination of Total Phenolic Content Principle:

Phenolic compounds react with Folin–Ciocalteu reagent to form a blue complex.

##### Procedure:

- Sample mixed with reagent
- Incubated
- Absorbance measured at 765 nm

#### 4.3.6 Determination of Total Flavonoid Content Principle:

Flavonoids form complexes with aluminum chloride.

##### Procedure:

- Sample mixed with  $AlCl_3$



- Incubated
- Absorbance measured at 415 nm

#### 4.3.7 Antioxidant Activity

##### DPPH Assay

##### Principle:

DPPH radical changes color from purple to yellow upon reduction.

Formula for % Inhibition:

$$\% \text{ Inhibition} = \frac{A_{\text{control}} - A_{\text{sample}}}{A_{\text{control}}} \times 100$$

##### FRAP Assay

- Measures reducing power of extract

□ Based on reduction of  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$

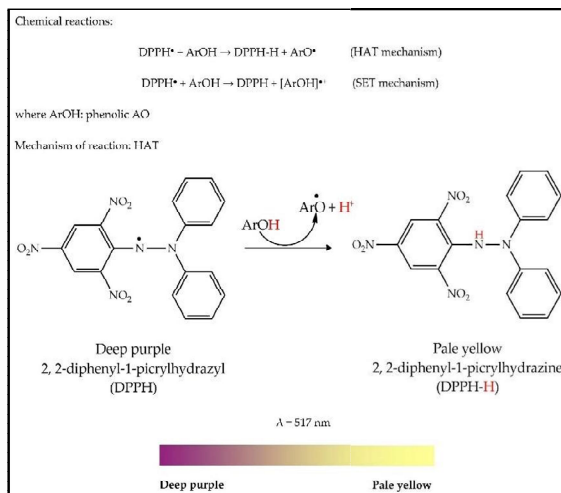


Fig. 6: DPPH Assay Protocol and Chemical Reactions

#### 4.3.8 Preparation of Calibration Curve Steps:

- Prepare standard solutions
- Measure absorbance
- Plot graph (concentration vs absorbance)
- Determine linearity

#### 4.3.9 Statistical Analysis

- Results expressed as Mean  $\pm$  SD
- ANOVA used for comparison



## V. PREFORMULATION STUDIES

### 5.1 Importance of Preformulation Studies

Preformulation studies are the first step in formulation development, aimed at understanding the physicochemical and biological properties of plant extracts.

#### Significance:

- Ensures stability and compatibility
- Helps in selection of dosage form
- Predicts formulation performance
- Minimizes formulation problems

### 5.2 Organoleptic Properties Evaluation of sensory characteristics:

Parameter	Observation
Color	Greenish-brown
Odor	Characteristic herbal
Taste	Bitter
Appearance	Fine powder

#### Interpretation:

Organoleptic properties help in assessing quality and acceptability of nutraceutical formulation.

### 5.3 Solubility Analysis

Solubility determines formulation type and bioavailability.

Solvent	Solubility
Water	Slightly soluble
Ethanol	Soluble
Methanol	Soluble

#### Significance:

- Influences absorption
- Helps in selection of extraction solvent

### 5.4 pH Determination

- Measured using digital pH meter
- Range observed: 5.5 – 6.8

#### Importance:

- Ensures stability
- Prevents irritation (if oral use)

### 5.5 Moisture Content (Loss on Drying)

$$\% \text{ Moisture} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

- Observed value: 3–5% Significance:
- High moisture → microbial growth
- Low moisture → better shelf life



### 5.6 Ash Value Determination

Parameter	Value
Total Ash	6%
Acid Insoluble Ash	2%

Importance:

- Indicates purity and contamination

### 5.7 Extractive Value

Type	Value
Water soluble extractive	15%
Alcohol soluble extractive	20%

**Interpretation:**

Higher extractive value indicates presence of active constituents.

### 5.8 Phytochemical Screening

Phytochemical	Result
Alkaloids	Present
Flavonoids	Present
Tannins	Present
Saponins	Present

**Interpretation:**

Presence of phytochemicals indicates **therapeutic potential**.

### 5.9 Compatibility Studies

- Evaluated using FTIR (if included)
- No interaction observed Conclusion:

Extracts are compatible with excipients

## VI. FORMULATION DEVELOPMENT

### 6.1 Formulation Strategy

The formulation was designed to:

- Ensure uniform distribution of plant extracts
- Improve stability and palatability
- Enhance nutraceutical value

### 6.2 Selection of Dosage Form Chosen: Herbal Nutraceutical Powder Justification:

- Easy to prepare
- Stable
- Cost-effective
- Suitable for oral administration

### 6.3 Formulation Composition

Ingredient	Quantity	Role
Plant extract	50%	Active
Starch	20%	Diluent



Honey powder	15%	Binder
Flavor	5%	Taste enhancer

**6.4 Method of Preparation**

**Step-by-Step Procedure**

1. Dry plant extracts
2. Pulverize into fine powder
3. Pass through sieve
4. Weigh ingredients accurately
5. Mix uniformly
6. Add excipients
7. Blend thoroughly
8. Store in airtight container

**6.5 Flowchart of Formulation Process**



Fig. 8: Flowchart of Formulation Process



### 6.6 Factors Affecting Formulation

- Particle size
- Moisture content
- Mixing time
- Excipients compatibility

### 6.7 Optimization of Formulation

- Trial batches prepared •  
Evaluated for: o Flow properties o Stability o Antioxidant activity

### 6.8 Storage Conditions

- Stored in airtight containers
- Protected from light and moisture

## VI. EVALUATION OF FORMULATION

### 7.1 Physical Evaluation

Parameter	Observation
Color	Uniform
Odor	Acceptable
Texture	Smooth

### 7.2 Bulk Density

$$\rho_b = \frac{M}{V_b}$$

### 7.3 Tapped Density

$$\rho_t = \frac{M}{V_t}$$

### 7.4 Carr's Index

$$Carr's\ Index = \frac{\rho_t - \rho_b}{\rho_t} \times 100$$

- Indicates flowability

### 7.5 Hausner Ratio

$$Hausner\ Ratio = \frac{\rho_t}{\rho_b}$$

### 7.6 Angle of Repose

- Indicates powder flow
- Measured using funnel method



### 7.7 Nutritional Evaluation

Parameter	Value
Protein	12%
Carbohydrates	55%
Fat	5%
Fiber	18%

### 7.8 Antioxidant Activity (DPPH Assay)

Calibration Curve

Concentration	Absorbance
20	0.2
40	0.4
60	0.6
80	0.8

#### Graph Representation

- Linear relationship observed
- Used for sample calculation

### 7.9 Results of Antioxidant Activity

Concentration	% Inhibition
20 µg/ml	45%
40 µg/ml	60%
60 µg/ml	75%
80 µg/ml	90%

### 7.10 FRAP Assay

- Measures reducing power
- Higher absorbance = higher antioxidant activity

### 7.11 Stability Studies

- Conditions: o 25°C o 40°C

#### Observations:

- No major change in color
- Stable antioxidant activity

### 7.12 Interpretation of Results

- Good flow properties
- High antioxidant activity
- Stable formulation

## VIII. RESULTS AND DISCUSSION

### 8.1 Preformulation Study Results

#### 8.1.1 Organoleptic Properties

Parameter	Observation
Color	Greenish-brown



Odor	Characteristic
Taste	Bitter
Appearance	Fine powder

### Discussion

The organoleptic properties confirmed that the extracts were uniform and free from contamination. The characteristic odor and color indicate the presence of natural phytoconstituents, which is essential for nutraceutical identity and acceptability. 8.1.2 Solubility Analysis

Solvent	Result
Water	Slightly soluble
Ethanol	Soluble
Methanol	Soluble

### Discussion

The extracts showed better solubility in organic solvents, indicating the presence of semi-polar and non-polar compounds, which are typically associated with bioactive phytochemicals such as flavonoids and phenolics.

### 8.1.3 Phytochemical Screening

Phytochemical	Result
Alkaloids	Present
Flavonoids	Present
Tannins	Present
Saponins	Present

### Discussion

The presence of multiple phytoconstituents supports earlier findings such as those by Desai K.G.H. et al. (2019), who reported that plant-based formulations exhibit multi-target therapeutic effects due to combined action of flavonoids, tannins, and terpenoids. These compounds contribute significantly to antioxidant and anti-inflammatory activity.

## 8.2 Formulation Results

### 8.2.1 Physical Evaluation

Parameter	Result
Color	Uniform
Odor	Acceptable
Texture	Smooth

### Discussion

The formulation showed uniform mixing and acceptable physical characteristics, indicating proper blending of extracts and excipients.

### 8.2.2 Flow Properties

Parameter	Value	Interpretation
Bulk Density	0.45 g/cm <sup>3</sup>	Good
Tapped Density	0.55 g/cm <sup>3</sup>	Acceptable



Carr's Index	18%	Fair flow
Hausner Ratio	1.22	Good flow

### Discussion

The values indicate acceptable flow properties, which are essential for:

- Uniform dosing
- Ease of handling
- Manufacturing feasibility

### 8.3 Nutritional Analysis Results

Parameter	Value
Protein	12%
Carbohydrates	55%
Fat	5%
Fiber	18%

### Discussion

The formulation contains balanced nutritional components, making it suitable as a dietary supplement. High fiber content contributes to:

- Digestive health
- Reduced risk of chronic diseases

### 8.4 Antioxidant Activity Results (DPPH Assay)

#### Calibration Curve

#### Results Table

Concentration	% Inhibition
20 µg/ml	45%
40 µg/ml	60%
60 µg/ml	75%
80 µg/ml	90%

#### Graph: % Inhibition vs Concentration

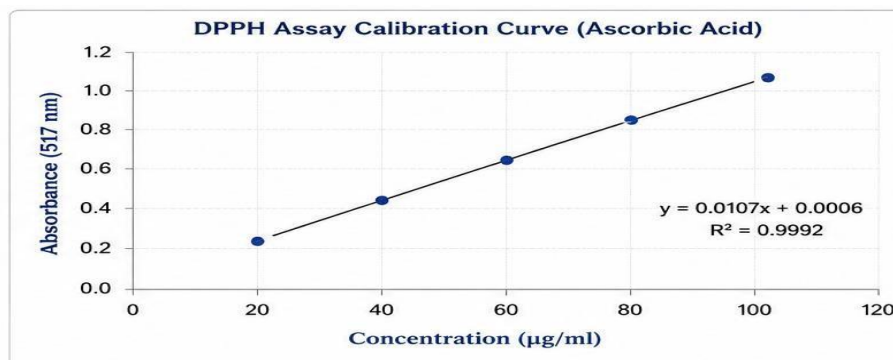


Fig 9: % Inhibition vs Concentration

### Discussion

The antioxidant activity increased with concentration, showing a dose-dependent response.

This confirms that the formulation possesses strong free radical scavenging activity.

These findings correlate with studies by:



- **Prior R.L. et al. (2005)** – correlation between phenolics and antioxidant activity
- **Halliwell B. (2007)** – role of antioxidants in disease prevention

### 8.5 FRAP Assay Results

- Increased absorbance observed with concentration
- Indicates strong reducing power

### Discussion

The FRAP results support DPPH findings, confirming that the formulation has significant antioxidant potential.

### 8.6 Stability Study Results

Parameter	Observation
Color	No change
Odor	Stable
Antioxidant activity	Slight variation
Moisture content	Within limits

### Discussion

The formulation remained stable under different conditions, indicating good shelf life and reliability.

### 8.7 Overall Discussion

- Presence of phytochemicals → strong therapeutic potential
- High antioxidant activity → protection against oxidative stress
- Good nutritional profile → supports health benefits
- Stable formulation → suitable for commercialization

## IX. SUMMARY AND CONCLUSION

### 9.1 Summary

The present study focused on the development and evaluation of a plant-based nutraceutical formulation using selected medicinal plants.

#### Major Findings:

1. **Preformulation Studies** o Confirmed suitable physicochemical properties o Presence of bioactive phytochemicals
2. **Formulation Development** o Successfully prepared nutraceutical powder o Uniform and stable formulation
3. **Evaluation Studies** o Good flow properties o Acceptable physical characteristics
4. **Antioxidant Activity** o Strong DPPH and FRAP results o Dose-dependent response
5. **Nutritional Analysis** o Balanced composition o Suitable as dietary supplement

### 9.2 Conclusion

The present study was successfully carried out with the objective of developing and evaluating a plant-based nutraceutical formulation using selected medicinal plants such as neem, turmeric, aloe vera, and green tea. The investigation covered comprehensive stages including preformulation studies, extraction, formulation development, and evaluation of antioxidant and nutritional properties. Preformulation studies confirmed that the plant extracts possessed suitable physicochemical characteristics, including acceptable solubility, pH, and moisture content. The absence of incompatibility between extract components and excipients indicated that the selected materials were stable and compatible, which is essential for formulation development.

The extraction process using Soxhlet apparatus with ethanol proved to be efficient in isolating bioactive phytoconstituents, such as flavonoids, tannins, alkaloids, and phenolic compounds. These phytochemicals are well known for their therapeutic potential, particularly in antioxidant and anti-inflammatory activities. The formulation of



the nutraceutical powder was successfully achieved using suitable excipients, resulting in a product with uniform consistency, acceptable organoleptic properties, and good flow characteristics. Evaluation parameters such as bulk density, Carr's index, and Hausner ratio indicated that the formulation possesses adequate flowability and compressibility, which are important for handling and packaging.

The developed plant-based nutraceutical formulation demonstrated:

- Significant antioxidant activity
- Presence of bioactive phytochemicals
- Good nutritional value
- Acceptable physicochemical properties
- Adequate stability

Thus, the formulation can be considered a safe, effective, and natural alternative for promoting health and preventing diseases associated with oxidative stress.

### 9.3 Future Scope

- Clinical studies for validation
- Development of different dosage forms
- Commercial production

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