

Development and Characterization of Herbal Protein Powder

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ABSTRACT

The present study focuses on the formulation and evaluation of a nutritionally rich herbal protein powder using natural plant ingredients Moringa oleifera (moringa leaf powder), Prunus dulcis (almond powder), Cucurbita pepo (pumpkin seed powder), Syzygium aromaticum (clove powder), Cinnamomum verum (cinnamon powder), and Stevia rebaudiana (stevia powder). The formulation (F1) was prepared by drying the ingredients in a hot air oven, finely powdering them, and mixing in fixed proportions moringa (15 g), almond (40 g), pumpkin seed (40 g), clove (0.5 g), cinnamon (4 g), and stevia (0.5 g) per 100 g. The prepared powder was subjected to phytochemical screening to identify bioactive constituents, and evaluated for organoleptic, physicochemical, and stability parameters over 30 days at room temperature. Phytochemical analysis confirmed the presence of alkaloids, flavonoids, glycosides, terpenoids, and proteins, indicating strong nutritional and therapeutic potential. The formulation exhibited a uniform color, pleasant aroma, smooth texture, and good solubility with stable pH and low moisture content. Physicochemical tests revealed favorable bulk and tapped density, Carr's index, and Hausner ratio, demonstrating good flow properties. Nutritional evaluation indicated a high protein and carbohydrate content with moderate fat, making it a balanced dietary supplement. During stability testing, only slight changes in color and aroma were observed, while other parameters remained stable, confirming good short-term storage stability. Overall, the developed herbal protein powder (F1) demonstrates excellent organoleptic acceptability, favorable physicochemical characteristics, nutritional balance, and stability, supporting its potential as a safe, effective, and natural alternative to synthetic protein supplements.

Keywords: Herbal protein powder, Moringa, Almond, Pumpkin seed, Clove, Phytochemical screening, Stability study, Nutritional supplement.

INTRODUCTION

In recent years, there has been a significant global shift toward plant-based and herbal nutrition driven by increased awareness of health, sustainability, and natural living. Among emerging trends, herbal protein powders have gained remarkable attention as safe and natural alternatives to animal-based or synthetic protein supplements. They offer not only a source of essential amino acids but also deliver a wide range of bioactive compounds, antioxidants, vitamins, and minerals, contributing to holistic health benefits. Proteins play a vital role in the human body by supporting tissue repair, enzymatic activity, immune response, and energy metabolism. However, conventional protein supplements, such as whey or

soy isolates, may cause allergic reactions, gastrointestinal discomfort, or long-term side effects in sensitive individuals. Therefore, the demand for chemical-free, nutrient-dense, and multifunctional herbal formulations is steadily increasing. The current research focuses on developing an herbal protein powder composed of moringa leaf powder, almond powder, pumpkin seed powder, clove powder, cinnamon powder, and stevia, each selected for its unique nutritional and therapeutic profile.

- Moringa is known as a “Miracle Tree,” offering all nine essential amino acids, antioxidants, and minerals such as iron, calcium, and potassium.

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

- Almonds provide healthy fats, vitamin E, and approximately 20–25% plant protein, supporting heart and brain health.
- Pumpkin seeds are a rich source of protein (30–35%), zinc, magnesium, and omega fatty acids, beneficial for muscle and immune health.
- Clove contributes antimicrobial, antioxidant, and digestive properties, enhancing both stability and palatability of the formulation.

Historically, these ingredients have been used for centuries in Ayurveda and traditional medicine systems for promoting vitality, strength, and longevity. Modern nutritional science now validates their combined benefits, making them ideal components of a functional food supplement. This study aims to develop, characterize, and evaluate a novel herbal protein powder for its organoleptic, physicochemical, phytochemical, and stability parameters, establishing its potential as a natural, balanced, and consumer-acceptable dietary supplement suitable for daily consumption.

2. Aim & Objectives:

Aim:

To develop and characterize a nutritionally balanced, organoleptically acceptable, and physically stable herbal protein powder formulated from natural plant-based ingredients such as *Moringa oleifera* (moringa leaves), *Prunus dulcis* (almonds), *Cucurbita pepo* (pumpkin seeds), and *Syzygium aromaticum* (clove), and to evaluate its phytochemical and physicochemical properties for potential use as a natural dietary supplement.

Research Objectives:

1. Preformulation Studies:

- To collect and authenticate raw materials: Moringa leaves, Pumpkin seeds, Almonds, and Cloves.
- To dry, roast, grind, and sieve the procured samples to obtain fine powders suitable for formulation.

- To prepare the herbal protein powder by mixing the ingredients in standardized proportions.
- To perform phytochemical screening of the formulation to identify the presence of bioactive compounds such as alkaloids, flavonoids, terpenoids, glycosides, and proteins.

2. Postformulation Studies:

a) Organoleptic Evaluation:

To assess the color, odor, and taste of the formulated herbal protein powder for sensory acceptability.

b) Physicochemical Evaluation:

- To determine solubility, bulk density, tapped density, Carr's index, Hausner ratio, and angle of repose to evaluate flow and handling properties.
- To measure pH, ash value, and moisture content to determine the formulation's stability and quality.
- To estimate the average per-dose nutritional value (protein, carbohydrate, and fat content).
- To conduct a stability study of the formulation over 30 days under room temperature conditions to monitor changes in organoleptic and physicochemical parameters.

4. Review of Literature:

Several studies have explored the nutritional and functional potential of natural plant ingredients such as moringa, pumpkin seeds, almonds, and cloves for use in herbal formulations.

1. A.K. Dhiman et al. (2018) reported that incorporating pumpkin flour and seed flour into food products like weaning mixes significantly enhanced their nutritional quality, demonstrating the value of pumpkin-based ingredients as natural protein and mineral sources.
2. Y. Singh et al. (2013) found that *Moringa oleifera* leaf powder, when properly dehydrated, retains its high nutritional and therapeutic properties, supporting its use as a dietary



supplement to improve nutritional intake in developing regions.

3. P. Bhadra et al. (2013) highlighted that *Syzygium aromaticum* (clove) contains active constituents like eugenol, providing antimicrobial, antioxidant, and anti-inflammatory benefits, making it useful as both a preservative and a therapeutic component in food formulations.
4. X. Shen et al. (2024) demonstrated that combining different plant-based proteins improves amino acid balance and nutritional value, suggesting the potential of blended protein systems for enhanced functionality.
5. L. N. Ariani et al. (2024) emphasized that Moringa leaf powder is rich in proteins, vitamins, and minerals, and also exhibits pharmacological properties such as antioxidant and anti-inflammatory effects, making it suitable for functional foods.

6. M. Hadidia et al. (2024) and N. M. Devi et al. (2024) both concluded that pumpkin seeds are sustainable, nutrient-dense sources of plant-based protein with potential for use in value-added and functional food products.

Overall, the reviewed studies support the development of a herbal protein powder utilizing moringa, almond, pumpkin seed, and clove, as these ingredients collectively provide essential nutrients, antioxidants, and health-promoting phytochemicals suitable for natural protein supplementation.

5. MATERIALS & METHODS:

5.1. Materials:

The drug chemicals and equipment used in the project research are given in the Table 5.1.1 and Table 5.2 . All the materials used were of analytical grade and procured either as gift samples or purchased.

Table no. 5.1.1: Instrument/Equipment

Sr. No	Equipment/Instrument name	Model/Company
1.	Grinder	Remimotor electronic, VasaiIndia
2.	Microwave	BiotechnicsIndia.
3.	Sieve	BestsievesIndia
4.	pHmeter	Rolex
5.	Ribbon blender	Remimotorelectronic, VasaiIndia.

Table no. 5.1.2: List of Materials

Sr. No.	Materials	Manufacturer
1.	Moringa leaf powder	Local market from Belagavi.
2.	Almond powder	Palan enterprises Mumbai.
3.	Pumpkin seeds powder	Prem enterprises Jaipur
4.	Clove powder	Local market from chandgad.
5.	Stevia powder	Local market from chandgad.
6.	Cinnamon powder	Local market from chandgad.



Table 5.1.3: Drug Profile of Herbal Ingredients Used in the Formulation of Herbal Protein Powder.

Sr. No.	Name (Synonym)	Biological Source	Morphological Features	Chemical Constituents	Uses
1	Moringa (Moringa oleifera)	Obtained from Moringa oleifera Lam., family Moringaceae. Known as drumstick tree or “Shevga.”	Fast-growing deciduous tree (5–10 m tall), compound leaves, white flowers, long three-sided pods (drumsticks).	Vitamins A, C, E, B-complex; minerals (Ca, Fe, Mg, Zn); proteins with all essential amino acids; alkaloids, flavonoids (quercetin, kaempferol), phenolic compounds, saponins, tannins, sterols.	Nutritional supplement, anti-inflammatory, antioxidant, antidiabetic, cardioprotective, antimicrobial, lactogenic, digestive aid.
2	Almond (Prunus amygdalus Batsch)	Dried kernel from Prunus dulcis (Mill.) D.A. Webb, family Rosaceae.	Small deciduous tree (4–10 m tall), serrated lanceolate leaves, white-pink flowers, drupe fruit with woody shell enclosing edible seed.	40–60% fixed oil (oleic, linoleic acids), 20–25% protein, vitamin E, B vitamins, minerals (Mg, Ca, P, K, Fe), flavonoids, phenolic acids, β -sitosterol, amygdalin (in bitter almonds).	Nutrient-rich snack, skin and hair care, brain tonic, used in bakery and confectionery, supports heart and nerve health.
3	Pumpkin Seeds (Cucurbita pepo L.)	Dried seeds from Cucurbita pepo L., family Cucurbitaceae.	Flat, oval, smooth seeds (white when unhulled, green when shelled), enclosed in fleshy pumpkin fruit.	35–50% fixed oils (linoleic, oleic acids), 30–35% protein, phytosterols (β -sitosterol), vitamins A, E, K, B-complex, minerals (Zn, Mg).	Nutritional supplement, heart and prostate health, antioxidant, anti-inflammatory, immune booster, aids sleep, improves skin and hair.
4	Clove (Syzygium aromaticum)	Dried flower buds from Syzygium aromaticum, family Myrtaceae.	Nail-shaped dried buds (10–17 mm long), dark brown, aromatic, with a dome-shaped unopened corolla.	Essential oil (eugenol 70–90%), acetyl eugenol, β -caryophyllene, vanillin, tannins, flavonoids, triterpenoids.	Flavoring agent, antiseptic, analgesic (toothache), digestive aid, cough remedy, anti-inflammatory, used in cosmetics and perfumes.

5.2. METHODOLOGY

5.2.1. PREFORMULATION STUDY

Preformulation is the preliminary stage in drug development that involves the systematic evaluation of the physical, chemical, and physicochemical properties of the drug or herbal material. The main



objective of preformulation studies is to collect essential data on the stability, solubility, and compatibility of the active ingredients with excipients, ensuring the development of a stable, safe, and effective formulation. These studies help predict potential formulation challenges, enhance product efficacy, and optimize the manufacturing process while reducing development time and cost.

Moringa leaf powder was procured from the local market in Belagavi, almond powder was obtained from Palan Enterprises, Mumbai, and pumpkin seed powder from Prem Enterprises, Jaipur. All raw materials were verified for authenticity and quality, then stored in airtight containers to prevent contamination and moisture absorption prior to formulation.

Collection of Raw Materials



Fig no 1: A. Moringa oleifera, B. Almond Seeds, C. Pumpkin seeds, D. Clove

Table no: List of Ingredients and Its Uses.

Name of the ingredients	Scientific name and family	Part used	Uses
Moringa powder	Moringa oleifera Family <i>Moringaceae</i>	Leaves	Nutritional supplement, antioxidant, anti- inflammatory, boosts immunity and digestion
Almond powder	Prunus dulcis Family <i>Rosaceae</i>	Seeds(nuts)	Rich protein source, supports heart health, skin, and brain function
Pumpkin seed powder	Cucurbitapepo Family <i>Cucurbitaceae</i>	Seeds	Plant protein source, Prostate and heart health, antioxidant
Cinnamon powder	Cinnamomum verum Family <i>Lauraceae</i>	Bark	Antioxidant, anti- inflammatory, blood sugar regulation
Clove powder	Syzygium aromaticum Family <i>Myrtaceae</i>	Fruit	Antimicrobial, anti- inflammatory, digestive aid

Table no 5.2.1: Formulation Table for Herbal Protein Powder

Ingredients	F1(gram)	F2(gram)
Moringapowder	15g	15g
Almond powder	40g	40g
Pumpkinseedpowder	40g	40g
Clove powder	0.5g	0.3g
Cinnamon powder	4g	4g
Steviapowder	0.5g	0.8g
Total	100gm	100gm

Method of preparation of herbal protein powder:

The herbal plant protein powder was prepared by collecting and cleaning all powders. The ingredients were dried using a hot air oven to remove moisture. Almond powder (20 g) and pumpkin seed powder (20

g) were finely ground and mixed with moringa powder (15 g). Stevia (2 g), cinnamon powder (2 g), and clove powder (1 g) were added for flavor. The mixture was blended thoroughly, sieved for uniformity, and stored in an airtight container in a cool, dry place



Fig no.2. Powders



Fig no 3. Drying



Fig.no.4. Sieving



Fig no.5 Final product

5.2.2. Phytochemical Screening of Herbal Protein Powder

The qualitative phytochemical screening of the formulated herbal protein powder was performed to identify the major classes of bioactive compounds such as tannins, saponins, flavonoids, alkaloids, phenols, glycosides, steroids, and terpenoids. These tests were carried out following standard phytochemical screening protocols as described in reference [30].

- 1. Test for Tannins:** About 200 mg of the plant extract was boiled with 10 mL of distilled water and filtered. To the filtrate, 0.1% ferric chloride solution was added. The appearance of a blue-black coloration indicated the presence of tannins.
- 2. Test for Alkaloids:** The plant extract was dissolved in 100 mL of distilled water, filtered, and the filtrate was heated with 2 mL of 1% hydrochloric acid. To 1 mL of the heated mixture, 6 mL of Mayer's and Wagner's reagents were added. The formation of a cream or reddish-

brown precipitate confirmed the presence of alkaloids.

- 3. Test for Saponins:** Approximately 0.5 mL of the extract was mixed with 5 mL of distilled water and vigorously shaken. The formation of a stable froth or foam indicated the presence of saponins.
- 4. Test for Flavonoids and Glycosides:** **For flavonoids**, 200 mg of the extract was mixed with 10 mL of ethanol and filtered. To 2 mL of the filtrate, concentrated hydrochloric acid and a few magnesium ribbon pieces were added. The formation of a pink or red coloration indicated the presence of flavonoids. **For glycosides**, 0.5 mL of the crude extract was treated with 1 mL of distilled water and sodium hydroxide solution. The appearance of a yellowish color confirmed the presence of glycosides.
- 5. Test for Steroids:** About 1 mL of the crude extract was mixed with 10 mL of chloroform followed by 10 mL of concentrated sulfuric acid. The formation of a bilayer a red-colored upper



layer and a greenish lower layer confirmed the presence of steroids.



Fig no. 6: Phytochemical screening of plant herbs.

6. Evaluation test of Herbal protein Powder:

6.1. Organoleptic Evaluation of Herbal Protein Powder:

The organoleptic evaluation assesses the sensory attributes of the herbal protein powder to determine its acceptability for consumption. The evaluation focused on colour, odour, and taste, which are critical parameters for consumer preference and compliance.

6.1.1. Colour

The colour of the herbal protein powder was evaluated visually under natural light to observe its appearance, uniformity, and overall acceptability. The F1 formulation exhibited a uniform greenish-brown colour, indicative of proper mixing and homogeneity of the ingredients. This coloration is consistent with the natural hues of Moringa leaves, almonds, and pumpkin seeds, suggesting minimal degradation or discoloration during processing.

6.1.2. Odour

Odour was assessed by smelling a small quantity of the powder. The F1 formulation exhibited a mild, characteristic herbal aroma without any rancid, musty, or off-odours. The pleasant aroma can be attributed to the natural volatile compounds present in clove and cinnamon, which enhance the sensory appeal. The absence of any unpleasant smell indicates

good freshness, proper storage, and stability of the formulation.

6.1.3. Taste

The taste evaluation was performed by reconstituting the powder in warm water (approximately 50–60°C). The formulation exhibited a balanced herbal flavor with a slight nutty note from almond and pumpkin seed powder. Mild sweetness from Stevia was perceptible, making it palatable without added sugar. No undesirable or bitter taste was detected, which demonstrates the formulation's acceptability for consumption. The subtle flavors from clove and cinnamon contributed to an enhanced sensory experience, making the powder suitable for daily intake.

6.2 Physicochemical Evaluation:

6.2.1 Solubility:

Solubility was evaluated in both hot and cold water to assess dispersion and hydration characteristics. Five grams of powder were dissolved in 100 mL of water, and the solution was observed for uniformity and clarity. The test was performed in triplicate to ensure reproducibility. The formulation exhibited good solubility with minimal sedimentation.





Fig no. 7: Solubility

6.2.2. Bulk and Tap Density

Bulk density was determined by measuring the mass per unit volume of the powder without compaction. Ten grams of sample were transferred into a 100 mL graduated cylinder, and the initial volume recorded. Bulk density (BD) was calculated using:

$$BD = M/v$$

Where,

M=Mass,

v= volume,

BD=Bulk density

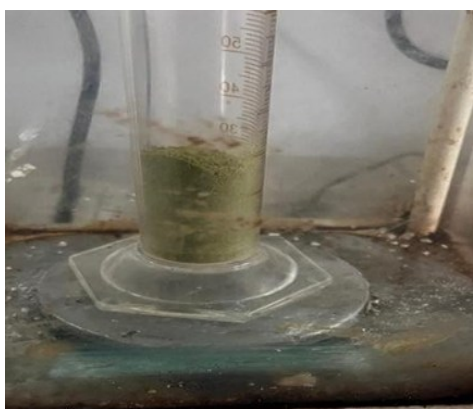


Fig no.8: Bulk Density

Tapped density was determined after mechanically tapping the cylinder until a constant volume was achieved. Tap density (TD) was calculated using:

$$TD = M/V$$

Where,

TD=Tap density,

M=Mass,

V=Volume

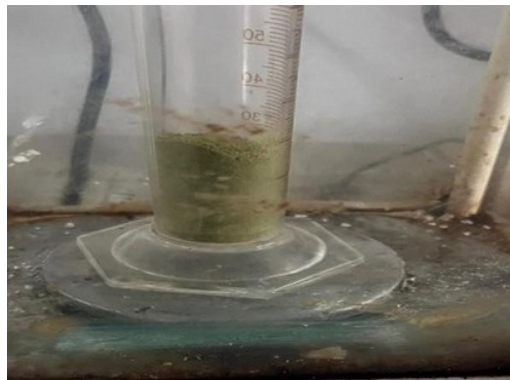


Fig no.9: Tapped Density

Both parameters indicated good flow properties suitable for handling and packaging.

6.3.3. Flow Properties

Carr's Index:

Evaluated using bulk and tapped density to assess compressibility:

$$CI = \frac{TD - BD}{TD} \times 100$$

Where,

CL=Carr's index,

TD=Tap density,

BD=Bulk density

Hausner's ratio:

Hausner Ratio was calculated as the ratio of tap density to bulk density to evaluate the flowability and cohesiveness of the herbal plant protein powder.

$$\text{Hausner's ratio} = \frac{TD}{BD}$$

Where,



TD=Tap density,

BD=Bulk density.

Angle of Repose:

Determined by allowing 10 g of powder to flow through a funnel onto a flat surface. Height (h) and radius (r) of the resulting conical heap were measured, and angle of repose (θ) calculated:

$$\theta = \tan^{-1}(h/r)$$

Fig No 10 : Angle of Repose.

Results indicated good powder flow and low cohesiveness, suitable for formulation.

pH :

The pH of a 10% w/v suspension (1 g powder in 9 mL distilled water) was measured using a calibrated digital pH meter. The powder exhibited a stable pH within the neutral to slightly alkaline range.

Ash Value

Total ash content was determined by incinerating 2 g of powder in a muffle furnace at 600°C until organic matter was completely burnt. The inorganic residue was weighed, and total ash percentage calculated:

$$\text{Total Ash(\%)} = \frac{\text{Weight of ash(g)}}{\text{Weight of sample(g)}} \times 100$$

Where,

Av=ash value,

w1=initial weight,

w2=in organic mineral content left



Fig no.11: Ash Value

Moisture Content:

Moisture content was assessed by oven-drying a known weight of powder at controlled temperature until a constant weight was achieved. The percentage moisture was calculated:

$$\text{Moisture Content(\%)} = \frac{\text{Initial weight of sample(g)} - \text{Final weight after drying(g)}}{\text{Initial weight of sample (g)}} \times 100$$

Nutritional Evaluation (Average Per Dose):

Nutritional content per serving was calculated based on 100 g powder composition. Macronutrients (protein, carbohydrates, fats, dietary fiber) and essential micronutrients were quantified using triplicate measurements:

$$\text{Nutrient per dose} = \frac{\text{Nutrient content in 100g of powder} \times \text{Weight of one serving(g)}}{100}$$

Stability Study:

The F1 herbal protein powder was stored in airtight containers at room temperature ($25 \pm 2^\circ\text{C}$, 60% RH $\pm$ 5%) for 30 days. Evaluations were performed on days 0, 15, and 30 for organoleptic (color, odour, taste) and physicochemical parameters (solubility, bulk and tap density, Carr's index, Hausner ratio, angle of repose, pH, ash value, and moisture content). All tests were conducted in triplicate ($n = 3$), and results were recorded as mean $\pm$ SD. The formulation showed only slight changes over the storage period, indicating good short-term stability.

7. RESULTS AND DISCUSSION:



7.1. Formulation of herbal protein powder:

The herbal protein powder was formulated using moringa, almond, clove, and pumpkin seed powders, along with cinnamon and stevia. These plant-based ingredients are rich in bioactive compounds, including flavonoids, alkaloids, phenolics, terpenoids, and essential fatty acids, which contribute to the powder's nutritional and therapeutic properties such as antioxidant activity, metabolic support, and immune modulation. The formulation was designed to ensure uniform texture, pleasant taste, and high solubility, with stevia improving palatability without affecting health benefits. The powder was evaluated through nutritional, organoleptic, and physicochemical tests to determine parameters like protein content, moisture, pH, flavor, and shelf stability, and the results were systematically recorded.

7.2. Evaluation tests for the Herbal protein powder:

Tests	Moringa powder	Almond powder	Pumpkin seed powder
Alkaloids	+	+	+
Glycosides	+	+	+
Flavonoids	+	—	+
Terpenoids	—	+	+
Proteins	+	+	+
Steroids	+	+	—
Saponins	+	+	+

(+) indicates presence whereas (—) indicates absence of the Phytochemical.

7.2.2. Organoleptic Evaluation

The sensory attributes of the F1 herbal protein powder were evaluated for colour, odour, and taste.

Apperance:

Table no.7.2.2: Organoleptic Properties.

Sr. no.	Parameters	Observation
1	Colour	Greenish
2	Odour	Characteristic herbal aroma
3	Taste	Slightly nutty flavour

Discussion:

The greenish colour indicates retention of natural pigments from Moringa and other plant-based ingredients. The characteristic herbal aroma is due to volatile compounds in clove, Moringa, pumpkin

seeds, and cinnamon. The nutty taste is contributed by almonds and pumpkin seeds. Overall, the formulation is organoleptically acceptable.

7.2.3. Physicochemical Evaluation:



Table no. 7.2.3: Physicochemical Evaluation

Parameter	Result (F1)	Observation
Solubility in cold water	0.53 ± 0.06 g/mL	Partially dissolved
Solubility in warm water	0.60 ± 0.05 g/mL	Completely dissolved
Bulk density	0.27 ± 0.01 g/cm ³	Light, fluffy powder
Tap density	0.30 ± 0.01 g/cm ³	Indicates good packing
Carr's index	10%	Excellent flowability
Hausner ratio	1.11	Good flow properties
Angle of repose	34.53 ± 0.08°	Freely flowing
pH	7.28 ± 0.13	Slightly neutral
Ash value	4.25 ± 0.12 %	Represents mineral content
Moisture content	1.4 ± 0.05 %	Low, enhances shelf life

Discussion:

The powder shows good solubility (especially in warm water), excellent flow properties, uniform

particle distribution, slightly neutral pH, and low moisture content, indicating stability and suitability for consumption and packaging.

7.2.4. Nutritional Evaluation (per 100 g):**Table no. 7.2.4: Nutritional Evaluation**

Sr.No.	TestParameter	Unit	Result	TestMethod
1	Protein	g/100 g	18.9	IS7219:1973
2	Moisture	g/100 g	1.4	FSSAI Manual
3	Total Fat	g/100 g	5.0	IS7874:1975
4	Total Carbohydrates	g/100 g	53.6	By calculation
5	Energy Value	Kcal/100g	335	By calculation
6	Sodium	mg/100 g	30.1	FSSAI Manual(Metals)

Discussion:

The formulation provides a balanced nutritional profile with high protein, moderate fat, and adequate

carbohydrates, making it suitable as a dietary supplement.

7.2.5. Stability Testing:**Table no. 7.2.5: Stability Study (30 Days at 25°C ±2°C, 60% RH ±5%)**

Evaluation Parameter	DURATION		
	0 Days	15 Days	30 Days
Color	No change	Slightly faded	Slightly faded
Odour	No change	No change	Mildly reduced herbal
Taste	No change	No change	Slightly less sweet/nutty
Solubility	0.60 ± 0.05	0.59 ± 0.05	0.58 ± 0.05
Bulk density(g/mL)	0.27 ± 0.01	0.27 ± 0.01	0.26 ± 0.01
Tap density(g/mL)	0.30 ± 0.01	0.30 ± 0.01	0.29 ± 0.01
Carr's index	0.30 ± 0.01	0.31 ± 0.01	0.31 ± 0.01
Hausner ratio	0.30 ± 0.01	0.31 ± 0.01	0.31 ± 0.01
pH	7.28 ± 0.13	7.25 ± 0.13	7.22 ± 0.13
Ash value(%)	4.25 ± 0.12	4.25 ± 0.12	4.24 ± 0.12
Angle of repose(°)	34.53 ± 0.08	34.55 ± 0.08	34.57 ± 0.08
Moisture content(%)	1.4 ± 0.05	1.45 ± 0.05	1.5 ± 0.05

±SD (n= 3).

Discussion:

The F1 formulation remained largely stable over 30 days, with minimal changes in colour, odour, taste, and physicochemical parameters, indicating good short-term stability and suitability for storage at room temperature.

8. CONCLUSION

The present study successfully developed and evaluated a herbal plant protein powder using Moringa leaf powder, almond powder, pumpkin seed powder, clove powder, cinnamon powder, and stevia. Preformulation studies ensured the selection of high-quality raw materials, verified their purity, and maintained proper storage to prevent contamination and moisture, providing a strong foundation for formulation development. The formulation process, including cleaning, drying, grinding, blending, and sieving, resulted in a uniform, greenish-brown powder with a characteristic herbal aroma and slightly nutty taste, reflecting successful retention of natural pigments and volatile compounds. Phytochemical screening confirmed the presence of alkaloids, glycosides, flavonoids, saponins, steroids, terpenoids, and proteins, indicating therapeutic and functional potential. Physicochemical evaluation demonstrated desirable characteristics: high solubility in warm water, low bulk (0.27 g/cm^3) and tap density (0.30 g/cm^3), excellent flow properties (Carr's index 10%, Hausner ratio 1.11, angle of repose 34.53°), slightly neutral to mildly alkaline pH (7.28), adequate mineral content (ash value 4.25%), and low moisture content (1.4%), indicating stability and suitability for oral consumption and packaging.

Nutritional analysis revealed a protein-rich formulation (18.9 g/100 g) with carbohydrates (53.6 g/100 g) and moderate fat content (5 g/100 g), providing a high-energy, nutrient-dense supplement. Short-term stability studies over 30 days at room temperature showed minimal changes in organoleptic, physicochemical, and nutritional parameters, confirming the formulation's stability.

In conclusion, the formulated herbal protein powder is nutritionally rich, organoleptically acceptable, physically stable, and functionally beneficial. Its solubility, flowability, and uniformity make it suitable for consumer use, supporting overall health, immunity, and wellness. The study provides a

foundation for further research on long-term stability, bioavailability, and clinical efficacy of this herbal protein formulation.

9. SUMMARY:

The herbal protein powder was successfully formulated using moringa, almond, clove, and pumpkin seed powders, with cinnamon and stevia for flavor and palatability. The formulation is rich in bioactive compounds such as flavonoids, alkaloids, phenolics, terpenoids, proteins, and essential fatty acids, providing nutritional, therapeutic, and antioxidant benefits. Phytochemical screening confirmed key secondary metabolites, while organoleptic evaluation showed a greenish color, characteristic herbal aroma, and slightly nutty taste, indicating retention of natural pigments and volatile compounds. Physicochemical evaluation revealed partial solubility in cold water ($0.53 \pm 0.06 \text{ g/mL}$) and complete solubility in warm water ($0.60 \pm 0.05 \text{ g/mL}$), with low bulk ($0.27 \pm 0.01 \text{ g/cm}^3$) and tap density ($0.30 \pm 0.01 \text{ g/cm}^3$), excellent flowability (Carr's index 10%, Hausner ratio 1.11, angle of repose $34.53 \pm 0.08^\circ$), pH 7.28 ± 0.13 , ash $4.25 \pm 0.12\%$, and low moisture ($1.4 \pm 0.05\%$), ensuring stability and ease of handling. Nutritional analysis indicated 18.9 g protein, 5 g fat, 53.6 g carbohydrates per 100 g, with 335 Kcal/100 g energy and low sodium (30.1 mg/100 g), reflecting a balanced nutrient profile.

Stability studies over 30 days at room temperature showed minimal changes in organoleptic, physicochemical, and nutritional properties, confirming good short-term stability. Overall, the formulated herbal protein powder is nutritionally rich, palatable, physically stable, and free-flowing, making it a promising functional food with potential health benefits.

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