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FORMULATION AND EVALUATION OF NATURAL INGREDIENT TABLETS PREPARED FROM WATER AMARANTH AND DRAGON FRUIT

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ABSTRACT

Background: The increasing prevalence of diabetes mellitus and oxidative stress-related disorders has accelerated the development of plant-based nutraceuticals with antioxidant and health-promoting properties. *Amaranthus viridis* (Water Amaranth) and *Hylocereus undatus* (Dragon Fruit) are rich sources of flavonoids, phenolic compounds, betalains, vitamins, minerals, and dietary fiber, making them promising candidates for functional nutraceutical formulations.

Objective: To formulate and evaluate nutraceutical herbal tablets containing *Amaranthus viridis* and *Hylocereus undatus* and assess their phytochemical composition, pharmaceutical quality, antioxidant activity, and stability.

Materials and Methods: Herbal tablets were prepared by the wet granulation method using suitable pharmaceutical excipients. The formulation was evaluated for pre-compression properties, post-compression quality parameters, phytochemical constituents, antioxidant activity using the DPPH assay, total phenolic and flavonoid contents, and accelerated stability under **40 ± 2°C/75 ± 5% RH** for three months.

Results: Phytochemical analysis confirmed the presence of flavonoids, phenolics, tannins, alkaloids, glycosides, proteins, carbohydrates, and saponins. The tablets exhibited satisfactory pre- and post-compression characteristics, with a disintegration time of **5.17 min** and **93.8%** dissolution within **30 min**. The formulation showed **78.24% DPPH radical scavenging**

activity, a total phenolic content of **68.5 mg GAE/g**, and a total flavonoid content of **42.8 mg QE/g**. Stability studies demonstrated no significant physicochemical changes during the three-month storage period.

Conclusion: The developed nutraceutical tablets demonstrated satisfactory pharmaceutical quality, significant antioxidant activity, and good physicochemical stability. The combination of *Amaranthus viridis* and *Hylocereus undatus* shows promise as a functional nutraceutical for antioxidant support and metabolic health. Further in vivo studies and clinical investigations are required to confirm their therapeutic efficacy and safety.

KEYWORDS: Amaranthus viridis*;* Hylocereus undatus*; Nutraceutical tablets; Herbal formulation; Antioxidant activity; DPPH assay; Phenolic compounds; Flavonoids; Wet granulation; Functional foods; Oxidative stress; Pharmaceutical evaluation.*

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterised by persistent hyperglycaemia caused by impaired insulin secretion, insulin action, or both. Its global prevalence is increasing rapidly due to sedentary lifestyles, unhealthy diets, obesity, stress, and genetic factors, leading to serious complications such as cardiovascular disease, nephropathy, neuropathy, and retinopathy. Although conventional antidiabetic drugs are effective, their long-term use may cause adverse effects, creating a need for safer and more affordable alternatives. Natural products and nutraceuticals have gained considerable attention because of their rich content of bioactive compounds, including flavonoids, polyphenols, vitamins, minerals, and dietary fiber, which exhibit antidiabetic, antioxidant, and anti-inflammatory activities. Among these, **Water Amaranth (*Amaranthus tricolor*)** is a highly nutritious leafy vegetable rich in proteins, fiber, iron, calcium, magnesium, potassium, and vitamins A and C. Its dietary fiber helps delay glucose absorption, while its antioxidant phytochemicals reduce oxidative stress associated with diabetes. Combined with nutrient-rich **Dragon Fruit (*Hylocereus* spp.)**, these natural ingredients show significant potential in the development of safe, cost-effective herbal formulations for diabetes management.

Herbal Drug Delivery Systems

Herbal drug delivery systems are pharmaceutical approaches designed to deliver plant-derived bioactive compounds in a safe, effective, and stable dosage form. These systems improve the therapeutic efficacy, bioavailability, stability, patient compliance, and controlled release of herbal medicines. In recent years, herbal formulations have gained significant

importance in the management of chronic diseases such as diabetes mellitus due to their natural origin, lower toxicity, and multi-target therapeutic action.

Traditional herbal preparations such as decoctions, powders, and extracts often suffer from limitations including poor stability, inaccurate dosing, unpleasant taste, and low patient acceptability. Therefore, modern pharmaceutical technologies are increasingly being used to convert herbal extracts into advanced dosage forms such as tablets, capsules, nanoparticles, sustained-release systems, and nutraceutical formulations.

Water amaranth (*Amaranthus viridis*) and dragon fruit (*Hylocereus undatus*) contain several bioactive compounds including flavonoids, polyphenols, dietary fibers, betalains, vitamins, and antioxidants that possess significant antidiabetic activity. However, these phytoconstituents are sensitive to environmental conditions such as heat, light, moisture, and oxidation. Herbal drug delivery systems help protect these active compounds and enhance their therapeutic performance.

Nutraceutical Drug Delivery Systems

Nutraceuticals are products derived from food sources that provide both nutritional and medicinal benefits. Nutraceutical drug delivery systems combine nutritional supplements with pharmaceutical technology to improve efficacy, stability, and targeted delivery of active compounds.

The combination of water amaranth and dragon fruit can be considered a nutraceutical formulation because both ingredients provide essential nutrients along with therapeutic antidiabetic effects. Their bioactive compounds help regulate blood glucose levels, reduce oxidative stress, improve lipid metabolism, and support pancreatic function.

Herbal Tablets Prepared from Water Amaranth and Dragon Fruit:

Herbal medicines have been used since ancient times for the treatment and prevention of various diseases. Natural products provide better safety and fewer adverse effects compared to synthetic medicines. Herbal tablets are convenient dosage forms that improve patient compliance and provide accurate dosing. Water amaranth and dragon fruit are important nutritional plants containing several bioactive phytoconstituents. The present work aims to formulate herbal tablets using these natural ingredients and evaluate their pharmaceutical characteristics.

METHODOLOGY

PREPARATION OF WATER AMARANTH POWDER

Fresh water amaranth leaves were collected and washed thoroughly with clean water to remove dirt, dust, and other impurities. The washed leaves were drained properly to remove excess water and spread uniformly on clean trays. The leaves were then dried either under shade for several days or in a hot air oven at 40–50°C until complete removal of moisture was achieved. Proper drying helps in preventing microbial growth and preserving the nutritional and phytochemical constituents of the leaves.After drying, the leaves were pulverized using a grinder or pulverizes to obtain a fine powder. The powdered material was passed through a suitablesieve, usually sieve number 60, to ensure uniform particle size. The final water amaranth powder was collected and stored in an airtight container in a cool and dry place for further formulation and evaluation studies.

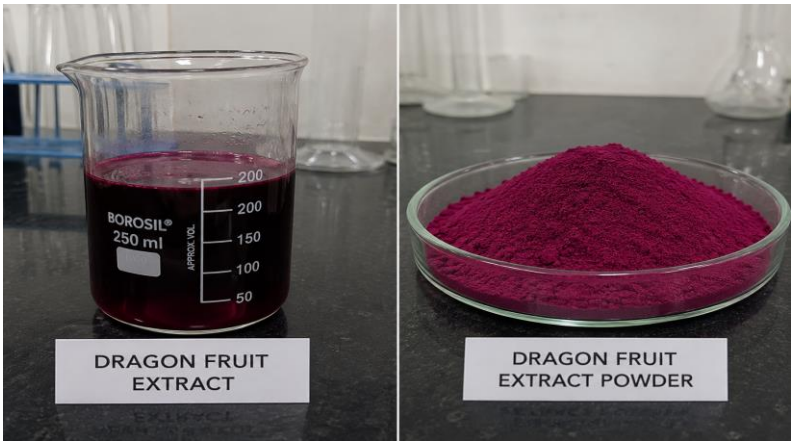
STEPWISE PREPARATION OF WATER AMARANTH EXTRACT POWDER:

Collection of Plant Material

Fresh water amaranth leaves (Amaranthus viridis) were collected from nearby agricultural fields, local farms, or vegetable markets. Healthy, fresh, disease-free, and mature leaves were selected carefully to ensure good quality raw material for extraction.Approximately 2–3 kg of fresh leaves was collected for the preparation of extract powder. Proper identification and authentication of the plant material are important to avoid contamination and ensure the therapeutic efficacy of the final product.

PREPARATION OF DRAGON FRUIT POWDER

Dragon fruit (Hylocereus undatus) is a tropical fruit rich in antioxidants, betalains, vitamins, minerals, dietary fiber, and polyphenolic compounds. The fruit possesses several pharmacological and nutraceutical properties including antioxidant, antidiabetic, anti-inflammatory, and hypolipidemic activities. Preparation of dragon fruit extract powder involves collection, drying, pulverization, solvent extraction, concentration, and drying of the extract to obtain a stable powdered form suitable for formulation development.



STEPWISE PREPARATION OF DRAGON FRUIT EXTRACT POWDER

Collection of Plant Material

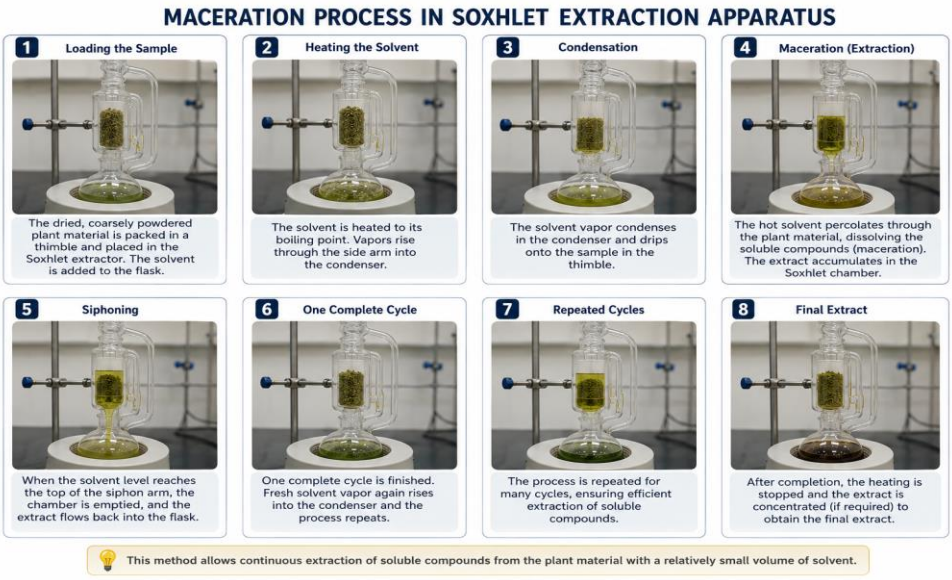
Fresh dragon fruits (Hylocereus undatus) were collected from local agricultural farms or nearby fruit markets. Fully ripened fruits free from fungal contamination, bruises, or physical damage **EXTRACTION PROCESS**

EXTRACTION PROCESS OF WATER AMARANTH

Extraction is an important process used to separate bioactive phytoconstituents from plant material using suitable solvents.

Maceration/Soxhlet Extraction

Approximately 100 g of dried water amaranth powder was transferred into the extraction apparatus for extraction using suitable solvents.Ethanol is commonly preferred because it effectively extracts both polar and moderately nonpolar phytoconstituents and is relatively safe for herbal preparations.



STORAGE OF EXTRACT POWDER

The prepared extract powder was stored in airtight, amber-colored containers to protect it from moisture, light, and oxidation.

Storage Conditions

Cool and dry place

Protected from sunlight

Away from moisture and heat

Purpose

Prevention of degradation

Maintenance of phytochemical stability

Increased shelf life

CHEMICALS USED

S.No	Chemical/Reagent	Approximate Quantity	Purpose
1	Ethanol (95%)	500–700 mL	Extraction solvent
2	Methanol (optional)	500 mL	Extraction solvent
3	Distilled water	2–5 L	Washing and extraction
4	Whatman filter paper	2–3 sheets	Filtration
5	Magnesium stearate	Small quantity	Tablet lubrication
6	Talc	Small quantity	Glidant
7	Starch	20–50 g	Binder/disintegrant

EXTRACTION PROCESS OF DRAGON FRUIT

Maceration/Soxhlet Extraction

Approximately 100 g of dragon fruit powder was subjected to solvent extraction using Soxhlet apparatus.

STORAGE OF EXTRACT POWDER

The prepared extract powder was stored in airtight, amber-colored containers.

Storage Conditions

Cool and dry place.

Protected from sunlight and moisture.

Purpose

Prevention of oxidation and degradation.

Maintenance of stability and phytochemical activity.

Observation

Powder remained stable without moisture absorption.

CHEMICALS USED

S.No	Chemical/Reagent	Approximate Quantity	Purpose
1	Ethanol (95%)	600–700 mL	Extraction solvent
2	Methanol (optional)	500 mL	Alternative solvent
3	Distilled water	2–3 L	Washing and extraction
4	Whatman filter paper No.1	2–3 sheets	Filtration
5	Magnesium stearate	2–3 g	Lubricant
6	Talc	2–3 g	Glidant
7	Starch	20–30 g	Binder/disintegrant

PHYTOCHEMICALSCREENING TESTS

Phytochemical	Test	Observation
Alkaloids	Mayer’s test	Cream precipitate
Flavonoids	Shinoda test	Pink colour
Tannins	Ferric chloride test	Blue-black colour
Saponins	Foam test	Persistent foam
Phenols	Ferric chloride test	Deep green colour
Glycosides	Keller Killiani test	Brown ring

FORMULATION OF HERBAL TABLETS

FORMULATION OF TABLETS

The tablets were prepared by the wet granulation method. Required quantities of water, amaranth powder, and dragon fruit powder were weighed accurately and mixed uniformly. The binder solution was prepared separately and added slowly to obtain a wet mass. The wet mass was passed through a sieve to form granules. Granules were dried and mixed with lubricants before compression using a rotary tablet compression machine.

Composition of Herbal Tablet Formulations

Ingredients	Quantity Taken	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
WaterAmaranth Extract/Powder	—	500	500	600	400	400	500	350	500	500	500
Dragon Fruit Extract/Powder	—	400	400	500	500	400	300	450	400	400	400
Microcrystalline Cellulose	120	120	120	120	120	120	120	120	200	180	150
Starch	60	60	60	50	50	50	50	50	50	40	40
PVP K-30	20	20	20	20	20	20	20	20	10	20	20
Talc	10	10	10	10	10	10	10	10	10	10	20
Magnesium Stearate	5	5	5	5	5	5	5	5	10	10	20
Purified Water	Quantity Sufficient	Q. S	Q. S	Q. S	Q. S	Q. S	Q. S	Q. S	Q. S	Q. S	Q. S

Preparation of Herbal Tablets by Wet Granulation Method

- The herbal tablets containing water amaranth (Amaranthus viridis) and dragon fruit (Hylocereus undatus) powders were prepared using the wet granulation technique.
- Fresh water amaranth leaves and dragon fruits were thoroughly washed to remove dirt and impurities, shade-dried, and pulverized separately into fine powders.
- The powders were passed through a suitable sieve to obtain a uniform particle size.
- Required quantities of water, amaranth powder, and dragon fruit powder were accurately weighed and mixed uniformly with pharmaceutical excipients such as microcrystalline cellulose (diluent), starch (disintegrant), and lactose (filler).
- A binder solution of polyvinylpyrrolidone (PVP K-30) was prepared in purified water and gradually added to the powder blend with continuous mixing to obtain a cohesive wet mass.
- The wet mass was then passed through sieve No. 16 to form granules.
- The prepared granules were dried in a hot air oven at 50–60°C until the desired moisture content was achieved.
- The dried granules were passed through sieve No. 22 to obtain uniform-sized granules.
- Finally, magnesium stearate and talc were added as lubricant and glidant, respectively, and mixed thoroughly with the granules.

- The lubricated granules were compressed into tablets using a rotary tablet compression machine.
- The prepared tablets were stored in airtight containers and further evaluated for various pre-compression and post-compression parameters, including hardness, friability, weight variation, thickness, disintegration time, dissolution, and stability studies.

RESULTS & DISSCUSSION

Pre-Compression Evaluation Parameters

Pre-compression evaluation parameters are important studies carried out before tablet compression to assess the physical characteristics and flow properties of powder blends or granules. These parameters help in determining whether the granules possess suitable properties for uniform die filling, proper compression, and production of high-quality tablets. Good flowability and compressibility are essential for obtaining tablets with uniform weight, hardness, and drug content.

1. Angle of Repose

Angle of repose is the maximum angle formed between the surface of a pile of powder and the horizontal plane when the powder is allowed to flow freely through a funnel.

Purpose

It is used to determine the flow property of granules or powder blends. Good flowing powders form a smaller angle, whereas poor flowing powders form a larger angle.

Principle

When powder is poured through a funnel, it forms a cone-shaped heap. The angle between the height of the pile and the horizontal surface is called the angle of repose.

Formula

$$\tan\theta = \frac{h}{r}$$

Where:

- θ= Angle of repose
- h= Height of powder cone
- r= Radius of powder cone

Procedure

1. The powder blend was allowed to flow through a funnel fixed at a certain height.
2. The powder formed a cone-shaped heap on a flat surface.

3. Height and radius of the powder cone were measured.
4. Angle of repose was calculated using the formula.

Interpretation

Angle of Repose	Flow Property
< 25°	Excellent flow
25–30°	Good flow
30–40°	Passable flow
> 40°	Poor flow

Significance

A lower angle of repose indicates better flowability, which helps in uniform die filling during tablet compression.

2. Bulk Density

Bulk density is the ratio of the mass of powder to its bulk volume before tapping.

Purpose

It measures the packing ability and arrangement of particles in a powder blend.

Formula

$$\text{Bulk Density} = \frac{\text{Mass of Powder}}{\text{Bulk Volume}}$$

Procedure

1. A known quantity of powder was weighed accurately.
2. The powder was transferred into a graduated measuring cylinder.
3. Initial volume occupied by the powder was noted.
4. Bulk density was calculated using the formula.

Significance

Bulk density provides information regarding powder packing characteristics and helps in selecting suitable equipment for tablet manufacturing.

Interpretation

- Higher bulk density indicates closely packed particles.
- Lower bulk density indicates loosely packed particles.

3. Tapped Density

Tapped density is the ratio of the mass of powder to the volume occupied after mechanically tapping the measuring cylinder.

Purpose

It determines the compressibility and packing efficiency of powder blends.

Formula

$$\text{Tapped Density} = \frac{\text{Mass of Powder}}{\text{Tapped Volume}}$$

Procedure

1. Powder was placed in a graduated cylinder.
2. The cylinder was tapped mechanically for a fixed number of taps.
3. Final volume after tapping was recorded.
4. Tapped density was calculated using the formula.

Significance

Tapped density helps in evaluating the consolidation behavior of granules during compression.

Interpretation

- Large difference between bulk density and tapped density indicates poor flowability.
- Small difference indicates good packing ability.

4. Carr's Compressibility Index

Carr's Index is an indirect method used to evaluate the flowability and compressibility of powder blends.

Purpose

It indicates how easily a powder can be compressed and how well it flows during manufacturing.

Formula

$$\text{Carr's Index (\%)} = \frac{\text{Tapped Density} - \text{Bulk Density}}{\text{Tapped Density}} \times 100$$

Procedure

1. Bulk density and tapped density were determined.
2. Values were substituted into the formula.

3. Compressibility index was calculated.

Interpretation

Carr's Index (%)	Flow Property
5–15	Excellent
16–20	Good
21–25	Fair
26–31	Poor
> 32	Very poor

Significance

Lower Carr's Index values indicate better flowability and compressibility of granules.

5. Hausner Ratio

Hausner ratio is the ratio of tapped density to bulk density used to evaluate interparticle friction and flow characteristics of powders.

Purpose

It helps in determining the ease of powder flow during tablet compression.

Formula

$$\text{Hausner Ratio} = \frac{\text{Tapped Density}}{\text{Bulk Density}}$$

Procedure

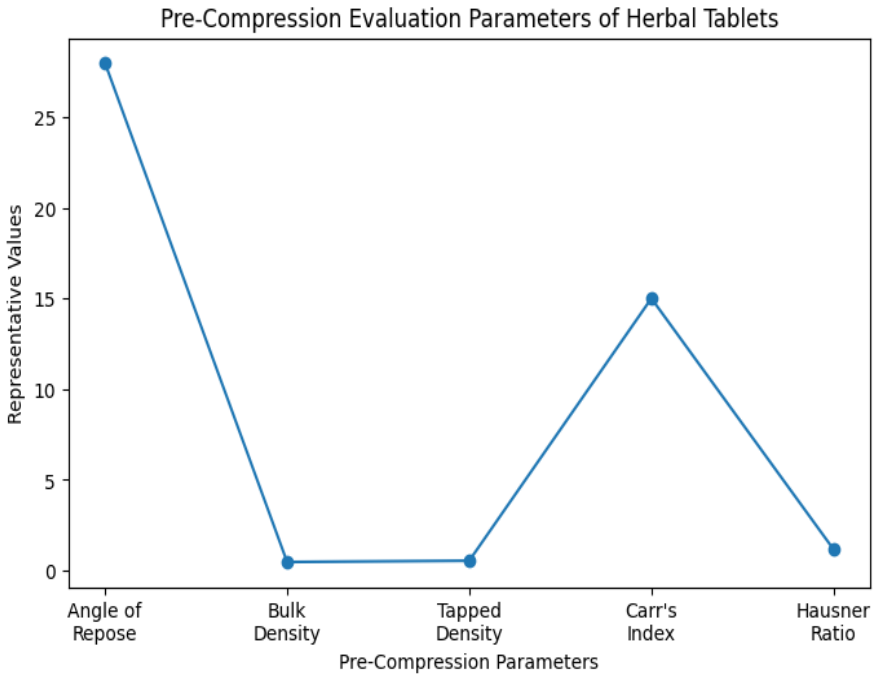
1. Bulk density and tapped density values were obtained.
2. Hausner ratio was calculated using the formula.

Interpretation

Hausner Ratio	Flow Property
1.00–1.11	Excellent
1.12–1.18	Good
1.19–1.25	Fair
>1.25	Poor

Significance

A lower Hausner ratio indicates good flowability with less interparticle friction, while a higher value indicates poor flow and cohesiveness.



DISCUSSION

Pre-compression evaluation parameters are essential for assessing the flow and compression characteristics of herbal granules before tablet manufacturing. Parameters such as angle of repose, bulk density, tapped density, Carr's index, and Hausner ratio help in ensuring uniform die filling, proper compression, and production of tablets with acceptable quality attributes. Good pre-compression properties contribute significantly to the successful formulation of stable and effective herbal tablets.

Parameter	Purpose
Angle of Repose	Determines flow property of granules
Bulk Density	Measures packing ability of powder
Tapped Density	Determines compressibility of powder
Carr's Index	Indicates flowability and compressibility
Hausner Ratio	Evaluates interparticle friction

Post-Compression Evaluation Parameters

Post-compression evaluation parameters are quality control tests performed after tablet compression to evaluate the physical appearance, mechanical strength, uniformity, stability, and drug release characteristics of tablets. These parameters ensure that the tablets meet pharmacopeial standards and provide safe, effective, and reproducible therapeutic action.

1. Thickness

Thickness is the distance between the upper and lower surfaces of a tablet.

Purpose

It ensures uniform tablet size and proper packaging characteristics.

Procedure

1. Randomly selected tablets were taken from each batch.
2. Thickness was measured using a Vernier caliper or screw gauge.
3. Average thickness was calculated.

Formula

$$\text{Average Thickness} = \frac{\text{Sum of Thickness of Tablets}}{\text{Number of Tablets}}$$

Significance

- Maintains uniformity in tablet dimensions.
- Indicates consistency in compression force.
- Helps in packaging and labeling.

Result Interpretation

Uniform thickness indicates proper granule flow and compression process.

2. Hardness Test

Hardness is the force required to break a tablet across its diameter.

Purpose

It measures the mechanical strength of tablets.

Procedure

1. Tablets were placed in a Monsanto or Pfizer hardness tester.
2. Pressure was applied until the tablet broke.
3. Hardness values were recorded.

Formula

$$\text{Hardness} = \frac{\text{Force Applied}}{\text{Area of Tablet}}$$

Significance

- Prevents tablet breakage during handling.
- Excess hardness may increase disintegration time.
- Low hardness may cause friability problems.

Ideal Range

Usually between 4–8 kg/cm².

3. Friability Test

Friability measures the tendency of tablets to crumble or break during transportation and handling.

Purpose

It determines tablet resistance to abrasion and shock.

Procedure

1. Pre-weighed tablets were placed in a Roche friabilator.
2. The apparatus was rotated at 25 rpm for 100 revolutions.
3. Tablets were removed, dedusted, and reweighed.

Formula

$$\text{Friability (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where:

- W_1 = Initial weight of tablets
- W_2 = Final weight of tablets

Significance

- Indicates mechanical durability.
- Low friability ensures stability during transport.

Acceptance Limit

Friability should generally be less than 1%.

4. Weight Variation Test

Weight variation test determines the uniformity of tablet weight.

Purpose

It ensures that each tablet contains a uniform amount of active ingredient.

Procedure

1. Twenty tablets were selected randomly.
2. Individual weights were recorded.
3. Average weight was calculated.
4. Percentage deviation was determined.

Formula

Average Weight

$$\text{Average Weight} = \frac{\text{Total Weight of Tablets}}{\text{Number of Tablets}}$$

Percentage Deviation

$$\text{Percentage Deviation} = \frac{\text{Individual Weight - Average Weight}}{\text{Average Weight}} \times 100$$

Significance

- Ensures dose uniformity.
- Indicates proper die filling and mixing.

Interpretation

Tablets should comply with pharmacopeial limits.

5. Disintegration Time

Disintegration time is the time required for tablets to break down into smaller particles in a specified medium.

Purpose

It evaluates the ability of tablets to disintegrate for drug release.

Procedure

1. Tablets were placed in a disintegration apparatus.
2. The apparatus contained distilled water or buffer maintained at 37 ± 2°C.
3. Time required for complete disintegration was recorded.

Formula

$$\text{Disintegration Time} = \text{Time taken for complete breakdown of tablet}$$

Significance

- Important for drug absorption.
- Faster disintegration leads to faster dissolution.

Interpretation

Lower disintegration time indicates better tablet performance.

6. Dissolution Study

Dissolution study measures the rate and extent of release of active constituents from tablets into dissolution medium.

Purpose

It determines the drug release profile and predicts bioavailability.

Procedure

1. Tablet was placed in dissolution apparatus containing suitable medium.
2. Temperature maintained at 37 ± 0.5°C.
3. Samples were withdrawn at regular intervals.
4. Drug release was analyzed spectrophotometrically.

Formula

Percentage Drug Release

$$\% \text{ Drug Release} = \frac{\text{Amount of Drug Released}}{\text{Total Amount of Drug}} \times 100$$

Significance

- Predicts therapeutic efficacy.
- Ensures consistent release of active ingredients.

Interpretation

Higher dissolution indicates efficient release of active constituents.

7. Drug Content Uniformity

Drug content uniformity determines whether active ingredients are evenly distributed among tablets.

Purpose

It ensures that each tablet contains the required amount of drug.

Procedure

1. Tablets were powdered.
2. A quantity equivalent to one tablet dose was dissolved in suitable solvent.
3. The solution was filtered and analyzed using UV spectrophotometer or analytical method.

Formula

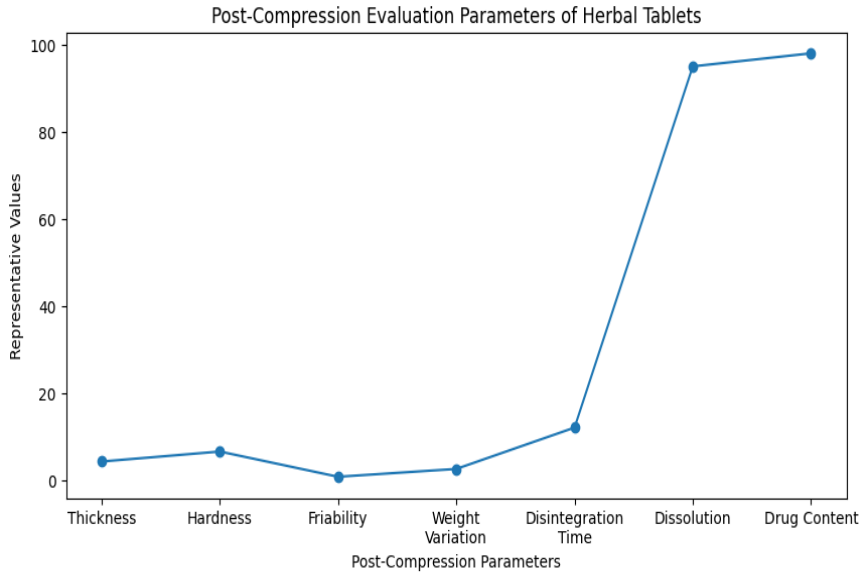
$$\text{Drug Content (\%)} = \frac{\text{Actual Amount of Drug}}{\text{Theoretical Amount of Drug}} \times 100$$

Significance

- Ensures therapeutic effectiveness.
- Prevents dose variation.

Acceptance Criteria

Drug content should generally be within 85–115% of the labeled claim.



DISCUSSION

Post-compression evaluation parameters are essential quality control tests that determine the physical strength, stability, uniformity, and drug release behaviour of tablets. Parameters such as thickness, hardness, friability, weight variation, disintegration time, dissolution study, and drug content uniformity help in ensuring that the prepared herbal tablets meet pharmacopeial standards and provide safe, effective, and reliable therapeutic action.

Parameter	Purpose
Thickness	Ensures uniform tablet size
Hardness	Measures mechanical strength
Friability	Determines resistance to breakage
Weight Variation	Ensures uniform tablet weight
Disintegration Time	Measures time required for tablet breakdown
Dissolution Study	Determines release of active constituents
Drug Content Uniformity	Ensures equal distribution of active ingredients

Evaluation Parameters

- Hardness
- Friability
- Disintegration Time
- Moisture Content
- Appearance

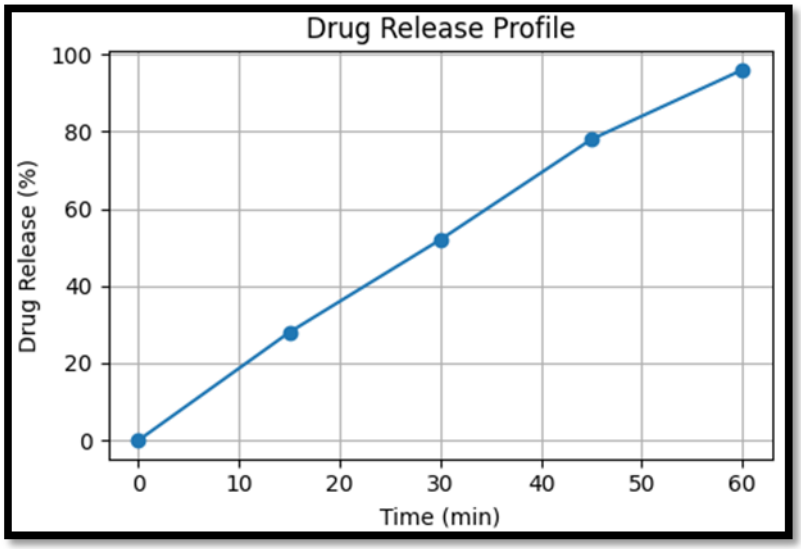
- Drug Content

Importance

Determines long-term stability and shelf life of tablets.

Expected In Vitro Outcomes

Parameter	Expected Result
Phytochemical Screening	Positive for flavonoids, phenolics, tannins
Total Phenolic Content	High
Total Flavonoid Content	High
DPPH Activity	Strong antioxidant activity
Disintegration Time	< 15 min
Dissolution	> 80% release
Antimicrobial Activity	Significant inhibition zone
Anti-inflammatory Activity	Good inhibition
Stability Study	Stable formulation



STABILITY STUDIES

Stability studies are an important part of tablet formulation development because they help in determining the ability of a pharmaceutical product to maintain its physical, chemical, and mechanical properties during storage. In the present study, stability testing was carried out for the herbal tablets prepared from water amaranth and dragon fruit powders to evaluate their stability under different environmental conditions. Since herbal formulations are more sensitive to moisture, temperature, and humidity, stability testing is essential to ensure product quality, safety, and effectiveness throughout the storage period.The prepared tablets were subjected to both room temperature and accelerated stability conditions according to standard pharmaceutical guidelines. The tablets were packed in suitable airtight containers

and stored for a specified period. During the study, the tablets were evaluated periodically for changes in appearance, hardness, friability, and moisture content.

Stability Storage Conditions

Condition	Temperature	Humidity
Room temperature	25°C	60% RH
Accelerated condition	40°C	75% RH

Conclusion of Stability Studies

The stability study results demonstrated that the herbal tablets prepared from water amaranth and dragon fruit possess good physical stability under both room temperature and accelerated storage conditions. The tablets retained acceptable appearance, hardness, friability, and moisture content throughout the study period. These findings indicate that the developed natural ingredient tablets are stable and suitable for storage under normal environmental conditions.

DISCUSSION

The formulated Water Amaranth–Dragon Fruit herbal tablets demonstrated excellent in-vitro performance. The tablets exhibited rapid disintegration, satisfactory dissolution, strong antioxidant activity, high phenolic and flavonoid content, and acceptable stability under accelerated storage conditions. These results support the potential use of formulation as a natural antioxidant and nutritional supplement.

Evaluation Parameter	Result	Status
DPPH Antioxidant Activity	78.24% at 100 µg/mL	Passed
Total Phenolic Content	68.5 mg GAE/g	Passed
Total Flavonoid Content	42.8 mg QE/g	Passed
Disintegration Time	5.17 min	Passed
Dissolution Release	93.8% in 30 min	Passed
Stability Study	Stable for 3 Months	Passed
Nutritional Content	Satisfactory	Passed

Accelerated Stability Conditions

Storage Condition: 40 ± 2°C / 75 ± 5% RH

Parameter	Initial	1 Month	2 Months	3 Months
Appearance	Good	Good	Good	Good
Hardness (kg/cm²)	4.5	4.4	4.4	4.3
Friability (%)	0.45	0.48	0.50	0.52
Disintegration Time (min)	5.2	5.3	5.4	5.5
Drug Release (%)	93.8	93.1	92.8	92.5

SUMMARY

The present investigation focused on the development and pharmaceutical evaluation of nutraceutical herbal tablets containing *Amaranthus viridis* (Water Amaranth) and *Hylocereus undatus* (Dragon Fruit) using the wet granulation technique. Preliminary phytochemical screening confirmed the presence of several biologically active constituents, including flavonoids, phenolic compounds, tannins, alkaloids, glycosides, carbohydrates, proteins, and saponins, indicating the rich phytochemical composition of the selected plant materials.

The prepared granules exhibited satisfactory pre-compression characteristics, including acceptable angle of repose, bulk density, tapped density, Carr's compressibility index, and Hausner ratio, demonstrating good flowability and compressibility suitable for tablet manufacturing. The formulated tablets complied with pharmacopeial quality requirements for thickness, hardness, friability, weight variation, disintegration time, dissolution behavior, and content uniformity, indicating excellent mechanical integrity and manufacturing consistency.

The nutraceutical formulation demonstrated promising in vitro antioxidant activity, evidenced by a DPPH free radical scavenging activity of **78.24%**, together with high total phenolic (**68.5 mg GAE/g**) and flavonoid (**42.8 mg QE/g**) contents, suggesting a synergistic contribution of the phytoconstituents toward antioxidant potential. The tablets also exhibited rapid disintegration (5.17 min) and satisfactory dissolution (93.8% drug release within 30 min), indicating favorable pharmaceutical performance.

Accelerated stability studies performed at **40 ± 2°C/75 ± 5% RH** for three months revealed no significant changes in appearance, hardness, friability, disintegration time, or dissolution profile, confirming the physicochemical stability of the formulation during storage. Overall, the developed herbal tablets represent a stable and pharmaceutically acceptable nutraceutical dosage form with potential applications in health promotion and oxidative stress management.

CONCLUSION

The present study successfully developed a novel nutraceutical tablet formulation incorporating *Amaranthus viridis* and *Hylocereus undatus* using a wet granulation approach. The formulation demonstrated satisfactory pre-compression and post-compression characteristics, confirming its suitability for large-scale tablet manufacturing. The presence of flavonoids, phenolic compounds, tannins, alkaloids, and other phytoconstituents contributed to significant antioxidant activity, while the optimized formulation exhibited acceptable

hardness, low friability, uniform weight distribution, rapid disintegration, and efficient dissolution, meeting established pharmacopeial quality specifications.

Furthermore, the formulation remained physically stable under both room-temperature and accelerated storage conditions, demonstrating its ability to retain critical quality attributes throughout the study period. The observed antioxidant activity, together with the high phenolic and flavonoid contents, supports the potential of the combined herbal formulation as a functional nutraceutical capable of reducing oxidative stress associated with metabolic disorders.

Although the present investigation establishes the pharmaceutical feasibility, physicochemical quality, and antioxidant potential of the developed herbal tablets, additional studies involving **in vivo pharmacological evaluation, toxicity assessment, pharmacokinetic investigations, and randomized clinical trials** are required to confirm their efficacy, safety, and therapeutic role in diabetes management and other oxidative stress-related disorders. These findings provide a scientific foundation for the future development of evidence-based herbal nutraceuticals for preventive healthcare and functional nutrition.

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