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Pharmacological Evaluation Of Momordica Diocia Roxb And Its Herbal Formulation

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ABSTRACT

Momordica dioica Roxb. (commonly known as spine gourd) is a medicinal plant widely used in traditional systems of medicine for the management of various ailments, including inflammation, diabetes, and infections. The present study focuses on the pharmacological evaluation of *Momordica dioica* and its formulated herbal preparation. Plant extracts were prepared using suitable solvents and subjected to preliminary phytochemical screening, which revealed the presence of bioactive constituents such as alkaloids, flavonoids, glycosides, tannins, and saponins. The pharmacological activities were evaluated through in vitro and in vivo models, including anti-inflammatory, analgesic, and antimicrobial assays. The herbal formulation was developed using optimized concentrations of the extract and evaluated for its efficacy and stability. The results demonstrated significant anti-inflammatory and analgesic activity, comparable to standard drugs, indicating the potential of *Momordica dioica* as a natural therapeutic agent. Additionally, antimicrobial studies showed inhibitory effects against selected bacterial and fungal strains. The formulation exhibited enhanced activity, suggesting possible synergistic effects of combined phytoconstituents. Toxicity studies confirmed the safety profile of the extract and formulation at tested doses. In conclusion, *Momordica dioica* possesses promising pharmacological properties that support its traditional use. The developed herbal formulation enhances its therapeutic efficacy and could serve as a potential alternative to synthetic drugs. Further studies involving clinical trials and mechanism-based investigations are recommended to validate its efficacy and safety for human use.

Keywords: *Momordica dioica*, pharmacological evaluation, herbal formulation, anti-inflammatory, analgesic, antimicrobial activity, phytochemicals.

INTRODUCTION

1.1 Statement of problem:

Annually, fibrotic diseases contribute to over 800,000 fatalities globally, with the preponderance attributed to pulmonary and cardiac fibrosis. The formation of fibrotic scars in cardiac muscle predominantly occurs following myocardial infarction; however, diverse conditions, including hypertensive heart disease, diabetic hypertrophic cardiomyopathy, and idiopathic dilated cardiomyopathy, also foster cardiac fibrosis. Despite the remarkable regenerative capabilities of the human body, minor defects caused by injury or disease can be remodeled or regenerated by resident cells, but not all defects can undergo proper regeneration. This is particularly pronounced in the context of the human heart. Cardiac fibrosis is a pathological condition characterized by excessive deposition of extracellular matrix proteins in the myocardium, leading to stiffening of the heart tissue.

In the pathogenesis of cardiac fibrosis, both oxidative stress and inflammation emerge as pivotal factors. Oxidative stress induces the generation of reactive oxygen species, precipitating organ damage. The heightened presence of reactive oxygen species exacerbates the accumulation of extracellular matrix,

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thereby fostering cardiac fibrosis. Oxidative stress-induced activation of NF-kB (nuclear factor kappa B) is a pivotal event, with pressure overload and Ang-II representing critical elements in this activation cascade. NF-kβ, functioning as an inflammatory modulator in cardiac fibrosis, undergoes activation upon exposure to specific triggers such as pressure overload and Ang-II. Activation of NF-kB initiates a cascade wherein the NF-kB target genes are upregulated, resulting in an escalation of reactive oxygen species, inflammation, and associated modulators, thereby contributing to the progression of cardiac fibrosis. The degradation of Ikβα is a requisite step, uncovering a nuclear localization signal on NF-kB and facilitating its translocation to the nucleus. Within the nucleus, NF-kB binds to its target genes, thereby instigating their expression and further amplifying the inflammatory response associated with cardiac fibrosis.[1]

The current diagnostic tools for assessing cardiac fibrosis are often limited in sensitivity and specificity, hindering early detection and intervention. Novel diagnostic approaches and biomarkers are needed to enhance our ability to identify patients at risk for or already experiencing cardiac fibrosis. Additionally, the development of non-invasive imaging techniques for accurate and timely monitoring of fibrotic progression is imperative for improving patient outcomes. Currently, various treatment options for cardiac fibrosis are available viz. ACE inhibitors, TGF-β inhibitors, loop diuretics, potassium channel blockers, Ang-II blockers. Nonetheless, after the effects of these treatment choices aren't agreeable enough and subsequently, a necessity for new treatment elective has ascended to fight this multi-faceted pathology.[2]

1.2 HARNESSING THE POTENTIAL OF MOMORDICA DIOICA THROUGH INNOVATIVE CUBOSOMES AND HERBAL TABLETS

The World Health Organization, better known as the WHO, has established specific standards for the assurance of safety, and strong quality control profiles, and also outlines the requirements for standardizing herbs, herbal products, and other forms of healthcare. Momordica dioica is a perennial, dioecious cucurbitaceous climbing plant. Kankoda; kakrol; spiny gourd; teasle gourd; akakara; bodakakara; kakor; kantola; golbandra; parora; kheksa; dharkarela; and batkarila are some of its other names.It is found on the Deccan Plateau and in central India, where it is indigenous to Asia. In addition to Bangladesh, Nepal, Myanmar, China, and Pakistan, it is also dispersed outside of India. It is frequently consumed as a healthy vegetable in addition to being used as a disease-curing agent. Among all the cucurbits, the fruits of this plant are notable for having a high concentration of carotene (162 mg for every 100 g of edible portions). Thiamine, Vitamin C, niacin, and riboflavin, are some of the vitamins[3] and minerals that are abundant in fruits, along with fibre, proteins, fatty acids (linoleic and oleic acid), and minerals including calcium, phosphorus, magnesium, iodine, and iron.

This study was conducted to set quality control standards for a significant Ayurvedic medicine using pharmacognostic parameters. These parameters included microscopic features, powder microscopy, and physicochemical and phytochemical analyses of Momordica dioica fruits. The research also utilized high-performance thin layer chromatography to examine various extracts. Furthermore, the study aimed to standardize the total phenol and flavonoid content of these extracts. Momordica dioica Roxb (MD), a perennial creeping plant that is native to India, Sri Lanka, Nepal, China, and Pakistan's tropical and subtropical regions, is a member of the Cucurbitaceae family. Given that it includes a variety of minerals and phytochemicals with significant medical potential, it is well-recognized as a folk remedy and a nutrient-dense vegetable.

The nanoparticle surface, the geometry of cubical particles makes them more suitable for drug delivery than alternative lipid-based drug delivery methods like solid lipid nanoparticles (SLN) and liposomes. Cubosomes with their rich architectural elements and attributes enabled a variety of desired results.Cubosomes have the following benefits when used as a medicine delivery system:[4]

➢ Different therapeutic compounds having hydrophilic, hydrophobic, and amphiphilic characteristics can be entrapped by them.

➢ Drugs with poor water solubility can have their bioavailability increased.

➢ They may be prepared using basic methods.

➢ Biodegradable lipids make up their structure.

➢ Due of their large interior surface, they exhibit significant drug loads.

➢ They enable targeted and regulated release of the bioactive therapeutic molecules. Drawback is huge manufacturing can occasionally be challenging due to high viscosity. Given the aforementioned information, the current work's goal is to protect the phytoconstituents against acidic environment, controlled release of constituents, and to achieve target site of action.

It is a tiny, oval to oblong vegetable called locally "Kikoda." The plant is an annual ascending creeper in the Cucurbitaceae family. When the fruit reaches maturity, it is short-beaked, heavily echinate with soft spikes, and greenish and yellow in colour. Momordica dioica Roxb. Is found chiefly in Asia and Africa. The plant's fruit, which has a variety of medical uses, is typically consumed as green vegetables. Momordica dioica was chosen since it is a common vegetable consumed by locals and has widespread usage in rural regions for various therapies. Additionally, several study findings highlighting the potential of Momordica dioica from diverse angles, such as plant components, animal models, or conventional drugs. Tablets are characterized as solid formulations designed for oral administration and having one or more active components in a single dosage. Compaction is used to create tablets filled with medication and formulation components.[5]

The leading drug manufacturers are currently looking into medicinal plants as potential sources for novel lead structures and to produce standardized phytotherapeutic molecules with established safety, efficacy, and quality. An individual must consume the necessary dose during the specified time to receive the intended benefit from herbal medications. The most popular type of product for pharmaceuticals that are taken orally is solid oral dosage forms. Unit dose forms provide the advantages of being handy, secure, and simple to handle and transport. An almost tamper-proof dosage form is the tablet. The tablet should be a classy item with a distinct identity, devoid of errors like splits, discolouration, cracks, and contamination, and strong enough to prevent the therapeutic substance from changing. A tablet's physical properties should be chemically and physically stable throughout time. This dosage form was chosen due to its practicality, simplicity of use, and capacity to hide herbal extracts' disagreeable tastes and odours. The current study aimed to develop and assess a unique herbal tablet using methanolic fruit extracts of Momordica dioica Roxb.

1.3 DEFINITION OF THE PROBLEM:

The problem addressed in the title "Phytopharmacological Evaluation of Momordica dioica Roxb. And its Herbal Formulation" involves conducting a comprehensive assessment of the pharmacological properties of Momordica dioica Roxb. And a herbal formulation derived from it, specifically in relation to their potential effectiveness in preventing or treating cardiac fibrosis. Phytopharmacological evaluation typically includes the study of the medicinal properties, bioactive compounds, and physiological effects of plant-derived substances. In this context, the focus is on understanding how Momordica dioica and its herbal formulation may impact heart fibrosis, a condition expressed by the excessive aggregation of fibrous tissue in the heart, which can lead to impaired cardiac function. The goal is likely to determine whether these natural products have therapeutic potential in mitigating or preventing cardiac fibrosis, possibly offering new insights for the development of herbal remedies or pharmaceutical interventions in the field of cardiovascular health.[6]

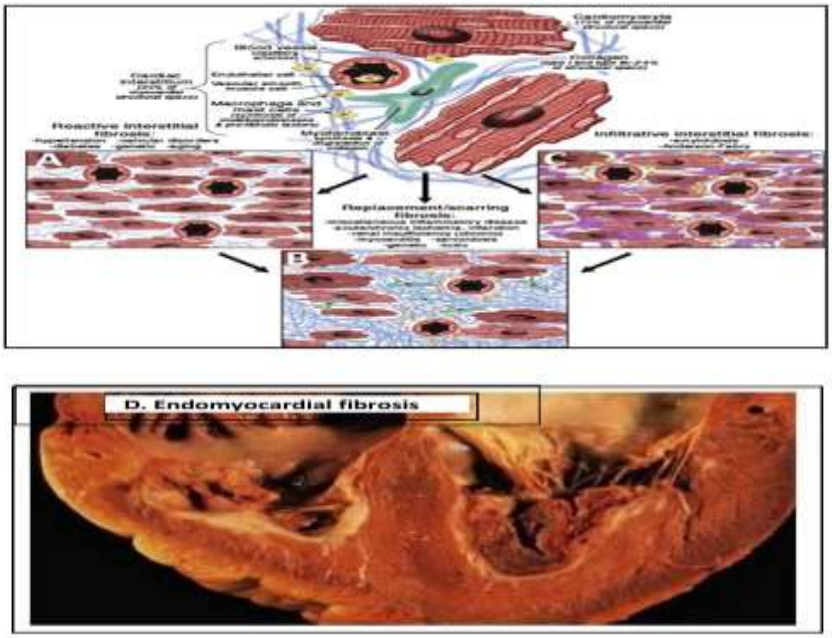


Figure 1: Diagrammatic presentation of types of cardiac fibrosis.

2. MATERIALS AND METHODS:

2.1 METHODS OF PHARMACOGNOSY AND PHYTOCHEMICAL EVALUATION OF MOMORDICA DIOICA FRUIT

- ***Collection and Authentication of Plant material***

The fruits of Momordica dioica Roxb. Were collected from the local market of Anand. Authentified by Dr. R. R. Acharya. Head & Research Scientist (Veg.), Main Vegetable Research Station, Anand agricultural university, Anand - 388 110, sakharkherda (India) against a voucher specimen AAU/ MVRS/EST/53/2021 on Dated 10/05/2026. The fruits used for the studies were sun-dried.

- ***Reagents and chemicals***

The whole inventory of chemicals and reagents used in the current investigation was purchased from Merk Life Science Pvt. Ltd. in Vikhori, Mumbai. Analytical grading was done on all other reagents.

Preparation of crude drug powder The Momordica dioica fruit was cleaned, rinsed, and chopped into little pieces before being dried in the sun for 7 to 8 days. After being pulverized at a monitored temperature in a plant sample grinder, the dried fruit (Figure 2) was then placed in a plastic container for storage.[7]

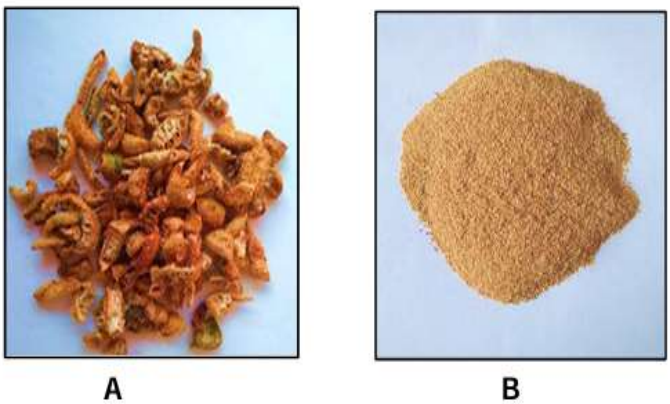


Figure 2: (A) Dried fruit (B) Crude drug powder of Momordica dioica.

2.2 TECHNIQUES OF PREPARING THE MOMORDICA DIOICA EXTRACT LOADED CUBOSOME, DESIGN AND CHARACTERIZATION

• ***Cubosome preparation***

In general, there are two primary methods for preparing cubosomes: top-down and bottom-up methods. Both of them need the use of an appropriate stabiliser, such F127, to stop cubosomes from aggregating.The most popular approach for cubosome synthesis is the top down technique. There are two key phases to it. First, create the bulk viscous cubic aggregates by combining the lipid that forms cubosomes with an appropriate stabiliser. Second, the use of high energy as a high-pressure homogenizer or sonication to the formed viscous cubic aggregates in aqueous medium eventually led to the creation of cubosomes. However, it has been discovered that cubosomes made by the top-down approach are persistent against aggregation lasting up to year. Another option is the bottom-up strategy, also known as the solvent dilution method, which involves dispersing a mixture of cubosomes that produce lipid, a stabilising agent, and a hydrotrope in surplus water using less energy. As it is used to breakdown water-insoluble lipids to create lipid precursors and stop the creation of liquid crystals at high concentrations, hydrotrope is the main component in the bottom-up strategy. A hydrotrope is a compound that may boost the solubility of one solute by the adding of another solute, making it possible for it to solubilize weakly soluble substances in aqueous conditions. Probably the most widely utilised hydrotropes are urea, sodium benzoate, and sodium alginate. The hydrotrope's solubilizing mechanism includes the hydrotrope and the hydrophobic agent forming a complex.

Table 1: Composition of cubosomal dispersion

Batches	Glyceryl monooleate (GMO) (% W/W)	Poloxamer 407 (%W/W)	Water (%W/W)
B1	5	1	94
B2	7.5	1	91.5
B3	10	1	89

• ***Preperation of MD extract loaded cubosomes***

Melted GMO was mixed with 1.5 grammes of MD extract. Using a magnetic stirrer set to 1500 revolutions per minute and 70 °C for an hour, the mixture was introduced dropwise to warmed water containing Poloxamer 407 while being constantly stirred. Place the solution for 48 hours after one hour. To create MD extract-loaded cubosomes, proceed by placing the solution through a high-speed homogenization process at 1500 rpm for an hour at 70°C.[8]

3. MICROSCOPIC STUDY OF MOMORDICA DIOCIA:

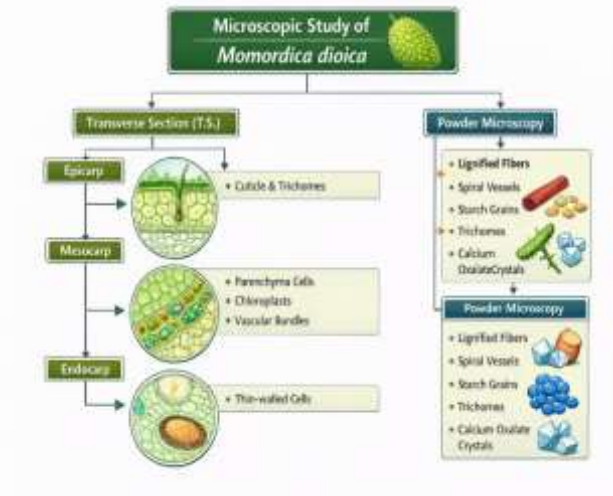


Figure 4. Microscopic study of momordica diocia

Table 2: Independent and dependent factors for experimental design and translation

Independent-variables	Level					
	Value coded			Value transformed		
	Minimal	Moderate	Maximum	Minimal	Moderate	Maximum
X_1= Amount of GMO (gm)	-1	0	1	8	10	12
X_2= amount of poloxamer 407 (gm)	-1	0	1	0.5	1.0	1.5
Dependent variables						
Response				Constrains		
Y_1 = % Entrapment efficiency				≥70 %		
Y_2 = % CDR at 1 hrs				15-40 %		
Y_3 = % CDR at 6 hrs				44-98 %		
Y_4 = % CDR at 8 hrs				75-100 %		

GMO: Glyceryl monooleate , % CDR: Percentage Cumulative drug release

Linear model: $Y = \beta0+\beta1X1+\beta2X2+\beta12X1X2$

Quadratic model: $Y=\beta0+\beta1X1+\beta2X2+\beta12X1X2+\beta3X12+\beta4X22+\beta5X1X22+\beta6X1X22$

where the intercept, denoted by β0, is the arithmetic mean of all the factorial runs' quantitative outcomes. In the case of factorial runs, the intercept denoted by β0 is the arithmetic mean of all the quantitative results; X1 and X2 represent the coded levels of the independent variables, whereas β1 and β2 are the coefficients determined from the observed values of Y. The terms X1X2 and X12, respectively, stand for the interaction and quadratic terms. The statistical validity of the polynomials was assessed using ANOVA (analysis of variance), and the feasibility and grid searches were then conducted to find the components of the optimal formulation. Additionally, the software used by the design experts produced 2-D contour maps.[9]

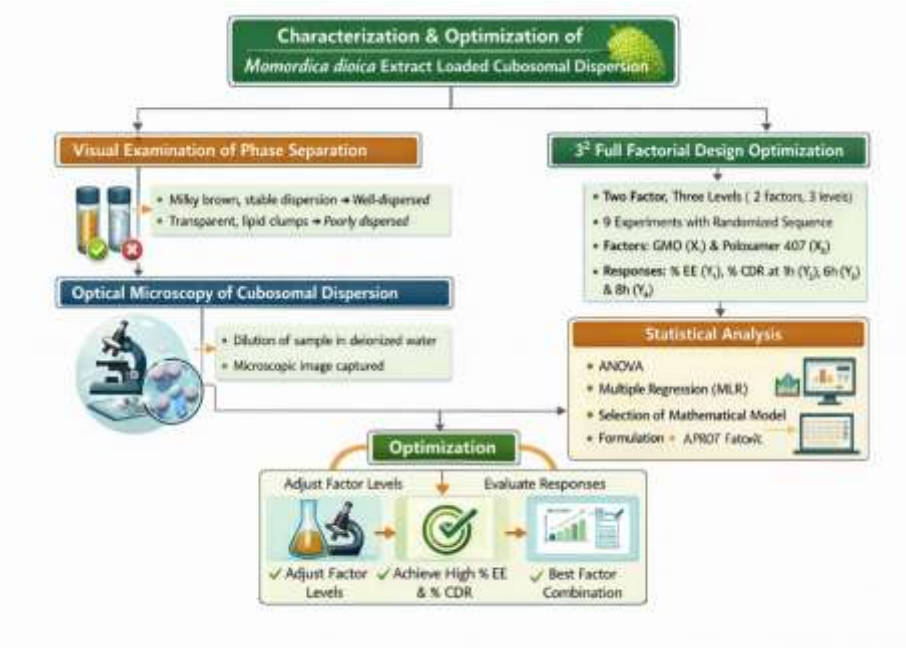


Figure 5. Characterization and optimisation of momordica diocia:

4. RESULTS AND DISCUSSION:

4.1 PHARMACOGNOSTIC EVALUATION OF MOMORDICA DIOICA FRUIT MACROSCOPIC EXAMINATIONS

The morphology of the fruit component that can be seen with the naked eye or magnifying glass is evaluated using a technique called macroscopic analysis. In order to discern the traits and ascertain the precise identification of crude pharmaceuticals, macroscopic evaluation is crucial. The fruit has a short beak, obtuse, and is heavily covered in soft spines. Fruit that is immature is green and turns yellow with age. The red pulp that surrounds the seeds is spherical, broadly ellipsoid, somewhat compressed, and irregularly corrugated. The fruit is 1-4 inches long and almost ovoid or ellipsoid in shape. The seed is many, ovoid, smooth, and dark brown. Fruits taste bitter and have an unpleasant smell.

Figure 5: Macroscopy of Momordica dioica fruit.



5. *Microscopic evaluation*

The fruit's transversely cut surface has a spherical shape and many exterior longitudinal rugose folds. The pericarp is divided into an outer, middle, inner, and endocarp. The glandular and multicellular trichomes are present on the epidermal cells, which are isodiametrically tangentially elongated With huge, isodiametric or radially elongated cells that appear to be empty of the cell sap and a network of tiny intercellular gaps, outer mesocarp tissue is made up of eight to ten layers (8–10). Middle mesocarp tissue has thick-walled cells with lignin and is polygonal in form with four to five layers. The interior mesocarp is made up of numerous layers of thin-walled cells that exhibit an enormous amount of starch relative to the outer layers. The central mesocarp is covered in tiny, floppy bundles of bicollateral vascular tissue that are organized in a ring. Endocarp tissue is thin and transparent and is made up of tiny, thin-walled, and tangentially elongated cells. The endosperm is made up of polygonal parenchyma surrounded by cotyledon tissue, oil globules, and aleurone grains.[10]

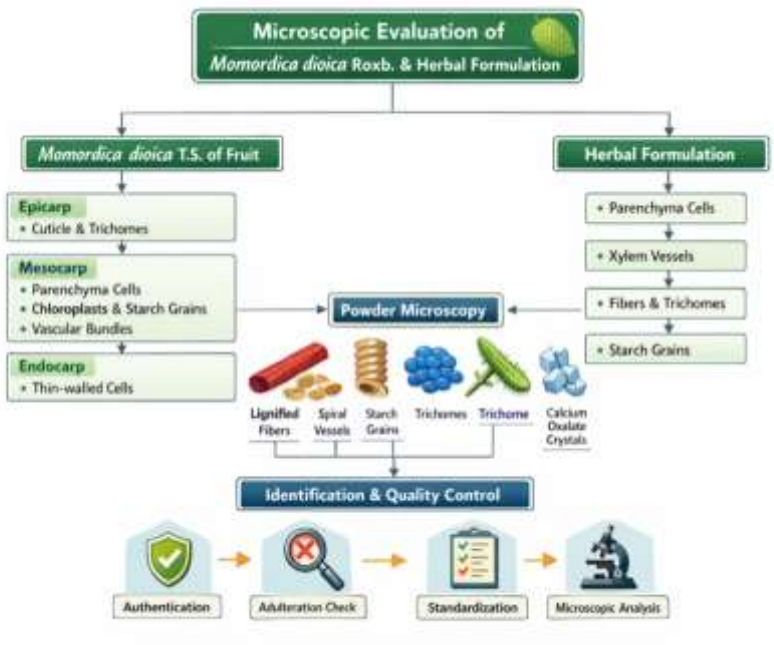


Figure 5. Microscopic Evaluatin of momordica diocia

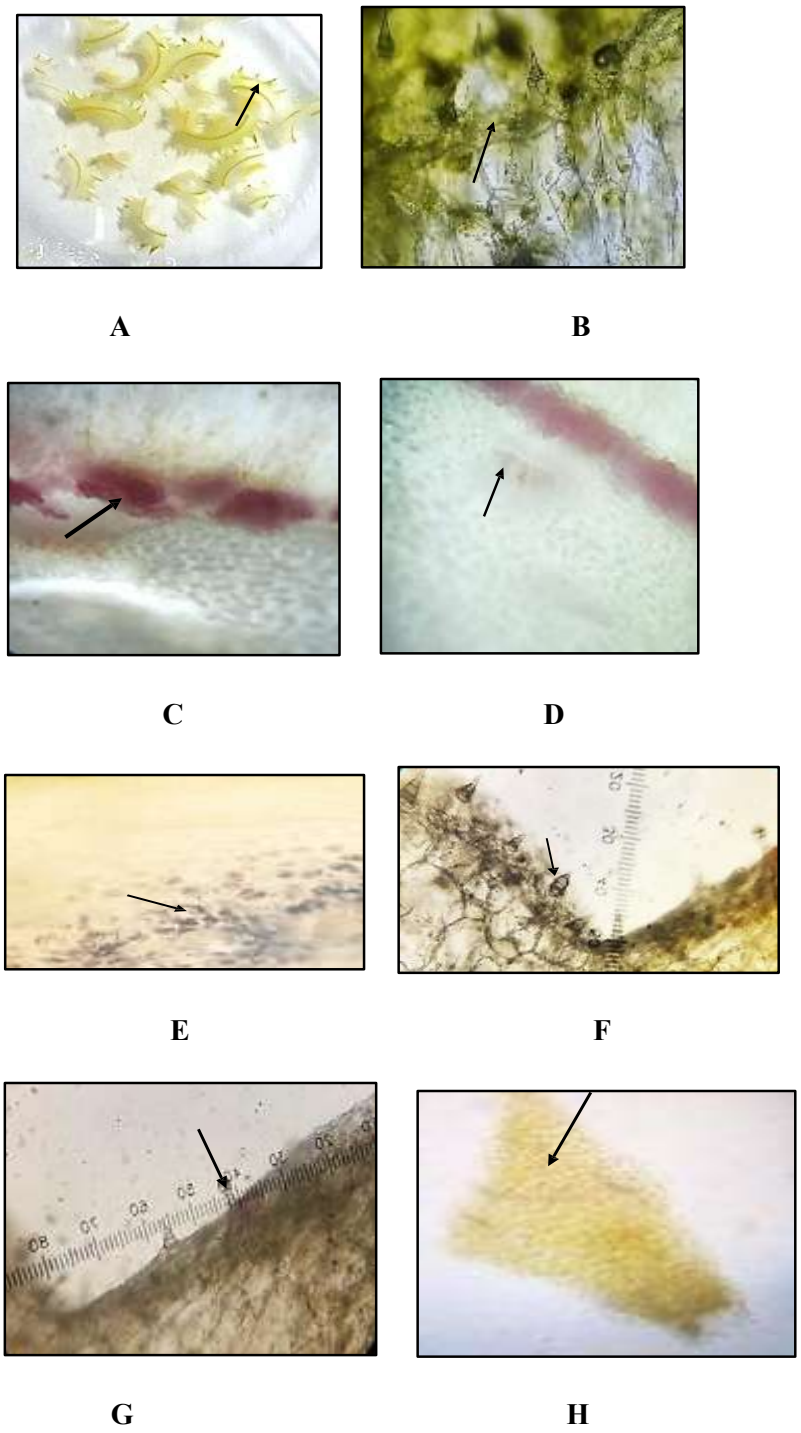


Figure 6: Cross sections of the immature fruit of Momordica dioica (A)An External longitudinal rugose folds (B) Epidermis (C)Middle mesocarp with thick-walled lignin cells (Stained with Phloroglucinol and concentrated HCI) (D) Inner Mesocarp with scattered Vascular Bundle (Stained with Phloroglucinol and concentrated HCI) (E) Inner mesocarp with thin-walled cells containing a lot of starch grains (F) Multicellular covering trichomes (G) Glandulartrichomes (H)Endosperm(Stained with alcoholic picric acid).

6. PowderMicroscopy

Momordica dioica dried fruits were examined for powder properties. Thepowder had a characteristic bitter taste and light brown color. When examined under a microscope, fruit powder reveals the presence of the Middle Mesocarp, fibers, epidermis, starch grain, Glandular trichomes, Multicellular trichomes,

Prism-like Calcium Oxalate Crystals, Spiral Vessels, Endosperm with Polygonal Cells, Secretory Cells (Figure 7).

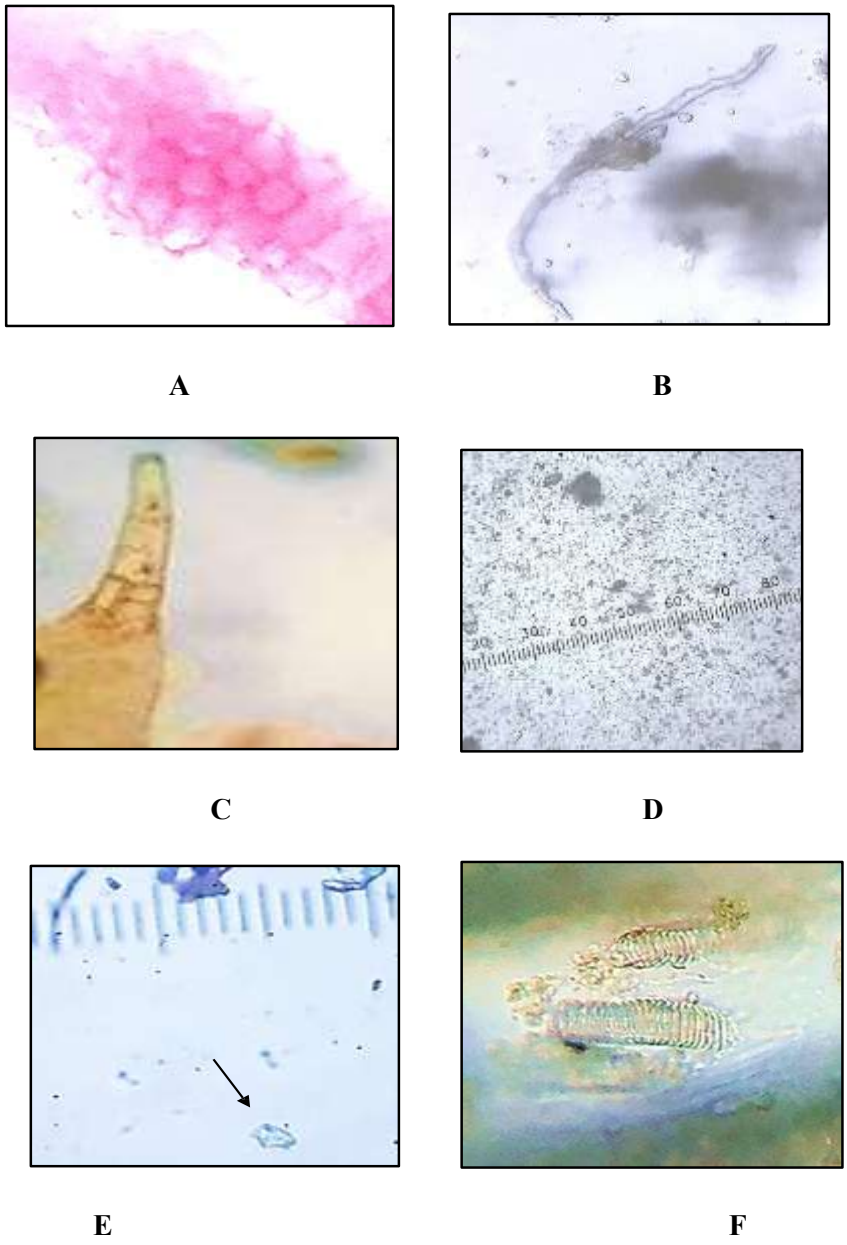


Figure 7: Powder microscopy of Momordica dioica fruit (A) Middle mesocarp (B) Fibers(C) Starchgrains (D) Multicellulartrichome (E) Prism type crystal (F) Spiral Vessels.

- ***Determination of foreign content and Loss on drying***

One of the key elements in evaluating the stability and deterioration of medications and formulations is loss on drying. Moisture content was calculated taking into account these details. *Momordicadioica*(MD)powder had a foreign matter level of 1.0±0.8%,and the dried aerial parts had a moisture content of 10.23 ± 0.72 % w/w.

- ***Determination of size of starch grains and Calcium oxalate crystals***

Starch grains of MD were simple and compound,oval to rounding shape,and the diameter of small grains, large grains, and average grains was 2µto9 µ, 10µ to

23µ, and 10µ respectively. No striations are visible and only very occasionally a hilum can be distinguished as a small dot.The presence of prism shape calcium oxalate crystals was large, single, and well-developed. The size of crystals was 13µ to 20µ and 23µ average size.

- ***Ash values & extractive value***

Ash values are significant as a qualitative benchmark because they can beused toassess the quality and purity of crude drugs. The mineral content of a crude drug, like carbonate, oxalate, and silicate, can be determined based on the ash value. In general, water-soluble ash is used to calculate the amount of inorganic compounds present in crude drugs and is a crucial indicator of whether or not the crude drug is exhausted by water, while acid-insoluble ash, which is primarily composed of silica, may indicate contamination with earthy material. The water, alcohol, and ether extractive values play a vital role in evaluating crude drugs and give an idea about the nature of the chemical constituents present in them. The alcohol-soluble extractive value revealed an important parameter in the evaluation of crude drugs. Based on the less extractive evalue it can be caused by certain factors such as exhaustion of crude drugs, adulteration, and due to the incorrect method during drying and storage. The water-soluble extractive value also revealed the same purpose as the alcohol-soluble extractive. The percentage of total ash, acid-insoluble ash, water- soluble ash , ethanol-soluble extractive, water, and ether-soluble extractive are presented in Table 5. The total ash, acid-insoluble, and water-soluble ash values were observed. tobe(7.4±0.1)%w/w,(2.3±0.1)%w/w,and(5.2±0.1)% w/w respective where the extractive value of ethanol, water, and ether was found to be (17.8 ± 0.3) % w/w, (20.5 ± 0.5) % w/w and (4.1 ± 0.2) % w/w respectively .[11]

Table5: Physico-chemical analysis of Momordicadioica

Standardization parameters	Mean±SEM (%w/w)
Total ash	7.4±0.1
Acid-insoluble ash	2.3±0.1
Water-solubleash	5.2±0.1
Ethanol soluble extractive values	17.8±0.3
Water soluble extractive values	20.5±0.5
Ether soluble extractive values	4.1±0.2

7. Extraction

Using a Soxhlet device ,petroleum ether and methanol were used to extract the fruit powder of *Momordica dioica* Roxb. The yield of the extracts from the MD fruit in petroleum ether and methanol was 5.03%and15.63%, respectively. The petroleum ether extract was an oily-viscous yellowish brown that solidified at 28 °C and the methanol extract was Semi-solid Dark Brown (Figure 8).



A B C

Figure8:(A)Soxhletextraction(B)Petroleumetherextract(C)MethanolextractofMomordicadioicafruit.

A.PRELIMINARY PHYTOCHEMICAL EVALUATION OF MOMORDICADIOICA

FRUIT

- ***Phytochemical screening of extract***

The preliminary phytochemical analysis can beused as a standardization toolto recognize, confirm, and detect falsification in order to guarantee quality control of the market's supply of crude drugs. The phytochemical screening of the petroleum ether and methanol extracts revealed the presence of proteins, alkaloids, carbohydrates, glycosides, steroids, terpenoids, tannins, saponins, phenolic compounds, and flavonoids in the methanol extract. Terpenoids and steroids are found in petroleum ether extract.

Table No. 6 Presents the findings.

Table6:Results of preliminary phytochemical investigation of extracts

Sr. No.	Chemical components	Petroleum ether extract	Methanol extract
1	Alkaloids	-	+
2	Carbohydrates	-	+
3	Anthraquinones	-	-
4	Glycosides	-	+
5	Cardiacglycosides	-	+
6	Steroids	+	+
7	Terpenoids	+	+
8	Tannins	-	+
9	Saponins	-	+
10	Flavonoids	-	+
11	Phenol	-	+
12	Proteins	-	+

+ = Present - = Absent

- ***Total phenolic content and total flavonoid content***

The total flavonoid concentration in the MD methanol extract was found to be 125 mg/g of quercetin equivalent, while the total phenol content was determined to be 64 mg/g of gallic acid equivalent. Figures 18A and 18B show the standard calibration curve visually. Findings regarding the overall flavonoid and phenol content in the study plant point to significant antioxidant elements that are responsible for neutralizing free radicals and preventing the development of various chronic illnesses, including cancer and cardiovascular disease.[12,13,14,15]

***B*. PREPARATION, OPTIMIZATION AND CHARACTERIZATION OF MOMORDICA DIOICA EXTRACT LOADED CUBOSOMES**

A top-down technique was used to create the cubosomes, and a high-speed homogenizer and probesonicator were used. Since it has been shown that the concentrations of lipid and stabilisers play the two main roles in determining the Particle Size and % EE performance characteristics of cubosomes.

- ***Characterization of Cubosomes:***

Visual examination

While batches B1 and B2 showed phase separation, batch B3 was determined to be stable and showed no signs of phase separation (Figure 9). The visual evaluation served as the main criterion for excluding very bad dispersionsfromfurtherinvestigation.HenceItwasdiscoveredthatnon-sonicated batch 3 with 10% of GMO generated stable cubosomal dispersion while batches with 5% and 7.5% GMO were rejected.



Figure 9: Optical microscopy of cubosomes batch B3 at magnification power of 1000 X.

8. CONCLUSION:

The study highlights the importance of ensuring quality and safety in herbal medications, especially within the growing Indian herbal industry. It examined various standardization parameters such as macroscopy, microscopy, and proximate analysis for Momordica dioica Roxb. fruit, providing a reliable tool for herbal research and quality assessment. These parameters help detect adulteration and establish quality standards, ensuring the herb's therapeutic value, safety, and stability.In the development of fast-release tablets, the study utilized PVP K30 as a binder and SSG as a disintegrant, with batch 5 showing the best qualities in terms of hardness, friability, weight variation, wetting time, disintegration time, and in vitro drug release. Pre- and post-compression analyses confirmed the tablets met regulatory standards. Stability studies revealed that the optimized tablet formulation remained stable for three months, confirming the compatibility of the extract with the excipients used in tablet preparation.

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