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MORPHOLOGICAL, ANATOMICAL AND PHYTOCHEMICAL INVESTIGATIONS OF *MORINDA CITRIFOLIA* L. BARK USING MACERATION TECHNIQUE

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ABSTRACT:

Morinda citrifolia L. (commonly known as Noni) is a medicinally important plant valued in traditional systems of medicine for its diverse therapeutic activities. The present study was conducted to investigate the morphological, anatomical and phytochemical characteristics *Morinda citrifolia* L. bark, with special emphasis on maceration-based extraction techniques. The bark samples were collected, authenticated and examined for morphological features including colour, texture, odour and surface characteristics, followed by detailed anatomical analysis through transverse and longitudinal sectioning. Microscopic observations revealed the presence of characteristic tissues such as thick-walled fibres, parenchymatous cortex, and Another stone cells which serve as diagnostic markers for species identification and quality control. Phytochemical profiling of the bark extract was performed using standard qualitative tests. The results confirmed the presence of major bioactive constituents including alkaloids, flavonoids, tannins, phenols, saponins, terpenoids and glycosides, indicating strong pharmacological relevance. The maceration technique proved efficient in extracting thermolabile phytochemicals while preserving their integrity. The study provides a comprehensive account of the morphology, internal anatomy and phytochemical constituents of *Morinda citrifolia* L. bark, contributing valuable data for Pharmacognostic standardization and future drug development. The findings support the ethnomedicinal significance of the plant and highlight its potential for use in herbal formulations.

Keywords:- *Morinda citrifolia* L.; Noni; Bark; Morphology; Anatomy; Microscopy; Maceration technique; Phytochemical screening; Alkaloids; Flavonoids; Tannins; Pharmacognostic evaluation; Herbal medicine.

INTRODUCTION:

Medicinal plants have been an integral component of traditional healthcare systems since ancient times. Herbal medicine continues to play a significant role in primary healthcare, particularly in developing countries. According to the World Health Organization (WHO), nearly 70–80% of the global population relies on plant-based medicines for their primary healthcare needs (Chauhan et al., 2015). India, being one of the world's biodiversity-rich regions, possesses a vast repository of medicinal plants that are extensively used in Ayurveda, Siddha, Unani, and other traditional systems (Sajani & Maya, 2020).

Morinda citrifolia L., commonly known as Noni, Indian mulberry, or cheese fruit, belongs to the family Rubiaceae and is widely recognized for its therapeutic potential. The plant is native to Southeast Asia and Australia and has achieved pantropical distribution due to its adaptability to diverse environmental conditions (Nelson, 2006; Rojas-Sandoval, 2017). Traditionally, various parts of the plant including roots, bark, leaves, flowers, and fruits have been used in the treatment of skin disorders, gastrointestinal ailments, inflammation, infections, metabolic disorders, and immune-related conditions (Wang et al., 2002; Rohit et al., 2015).

Phytochemical investigations have revealed that *M. citrifolia* contains diverse bioactive constituents such as alkaloids, flavonoids, phenolic acids, iridoids, anthraquinones, coumarins, tannins, and

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terpenoids, which contribute to its wide spectrum of pharmacological activities including antioxidant, anti-inflammatory, antimicrobial, immunomodulatory, antihyperlipidemic, and anticancer properties (Mohammad Ali et al., 2016; Hardeep et al., 2018; West et al., 2018). Phenolic compounds are known to play a crucial role in combating oxidative stress and related degenerative disorders (Jian et al., 2009).

Although extensive studies have been conducted on the fruit and leaves of *M. citrifolia*, comparatively fewer investigations have focused on its bark. Bark serves as an important medicinal raw material in several herbal formulations and is rich in secondary metabolites responsible for therapeutic activity. Proper pharmacognostic standardization of bark is essential to ensure authenticity, quality control, and prevention of adulteration. Morphological and anatomical studies provide diagnostic features for species identification, while physicochemical parameters establish purity standards (Esau, 1965; Khandelwal, 2005).

Maceration techniques play a vital role in anatomical investigations by separating individual cellular elements such as fibres, vessels, and parenchyma cells, which are important for taxonomic authentication (Johansen, 1940). Furthermore, qualitative phytochemical screening helps in identifying major groups of bioactive compounds present in crude plant material, thereby correlating structural characteristics with chemical composition.

the present study aims to conduct a comprehensive pharmacognostic evaluation of *Morinda citrifolia* bark through detailed morphological, anatomical, maceration, physicochemical, and phytochemical investigations. The findings of this study are expected to contribute to the establishment of standard parameters for identification and quality assessment of *M. citrifolia* bark, supporting its safe and effective utilization in herbal medicine and future drug development.

METHODOLOGY

Bhatala lake is a freshwater perennial lake of Warora tehsil of Chandrapur district of Vidarbha region. Latitude of the lake is 20.350969 and longitude 79.083062 having elevation- 217.67 ± 44m. A large number of aquatic weeds are thriving in its basin which was shallowed during summer season. Aquatic macrophytes (weeds) were observed in 2 years span from 3 different study areas. It was divided into winter (November-January) pre monsoon (February to April), Monsoon (June-August), post monsoon (September-October).

The water depth of lake varies in different seasons of the year so observations are done in all the season of the lake basin during 2024 & 2025. Aquatic weeds were surveyed and photographed and identified using Cook (1996). The unidentified weeds were collected by fisherman's help and bought to IHLR & SS in Zoology Laboratory of Nilkanthrao Shinde Science and Arts college, Bhadrawati and identified using standard available literature.

DISRIBUTION:

Morinda citrifolia L. originated from Southern Asia and subsequently distributed by humans or other means into the islands of the Western pacific (Pandiselvi et. al.) This small evergreen tree or shrub is native from Southeastern Asia (Indonesia) to Australia and now has a pantropical distribution (Nelson ,2006).

Morinda citrifolia can be cultivated in full or partial sunlight with well-drained and well-aerated soil free from nematodes, dry plants, and weeds. It can withstand/tolerate harsh conditions therefore it is also known as 'starvation fruit'. It is cultivated in tropical–subtropical countries like Bangladesh, British Indian Ocean Territory (BIOT), Chagos Island, Cambodia, Cocos Island, Keeling Island and India (Patil et al., 2018).

BOTANICAL DESCRIPTION:

There are over 80 species in the genus Morinda (Rubiaceae), including the species M. citrifolia

(Awari and Gampawar). M. citrifolia is a small, fruit-bearing, evergreen shrub or tree that now grows throughout the tropics (Chan-Blanko et. al.). in the form of shrubs to small trees with a height of up to 8 m or more. The young stems are rectangular and have stipules at the base of the petiole. Stipules are oval or triangular with a length of 4-16 cm. The leaf is a leaf which is arranged in front of each other and alternately. Petiole has a length between 5–20 mm (Figure 1a). Leaf shape is oval, oval, oval or round egg, 10–25 × 5–13 cm and the surface of the leaf is shiny. Flowers are compound that are composed of tubers. Flower stalk length 1–1.5 cm and diameter 5–10 mm. The petals are small, while the mouthpieces are funnel-shaped and tubular with a size of about 1.5 cm. The fruit is ovate or nearly round with a size of 2.5–5 cm green when young, while the ripe fruit is creamy white (Marina Silalahi).

MATERIAL AND METHODS:

A bark sample of Morinda citrifolia was taken from the campus of Dr. Babasaheb Ambedkar Marathwada University in Chhatrapati Sambhajinagar for the current study, and its morphological and anatomical characteristics were examined. Free-hand sections were obtained for the anatomical investigation, double-stained, and permanently mounted using the usual procedure (Esau, 1965). The sections were then examined using a compound microscope. The dry bark samples were macerated with jeffery's macerating fluid as described by (Johanson 1940).

Plant Material collection

The stem bark of *Morinda citrifolia* was collected by self in the month of July Latitude N19o,52',25.3" Longitude E075o,37'50.3" Altitude 474.5 m, from Aurangabad. Bark was pulverized in the mechanical grinder to a fine powder to carry out different pharmacognostical and phytochemical evaluation and was stored in a well closed airtight vessel for further analysis (Table No: - 1).

Behaviour of bark powder towards some chemical reagents.

The powder of *Morinda citrifolia* bark was treated with different chemical reagents. The mixture of the powdered drug and chemicals were allowed to warm and cold down for two hours. Changed colour of powdered drug was noted (Table No: - 2).

Physico-chemical Evaluations.

Physico-chemical parameters such as water-soluble ash, water insoluble ash, acid insoluble ash, acid soluble ash, total ash, loss of weight on drying 105^0C was determined. Considering the diversity of chemical nature and properties of contents of drugs, different solvents benzene, petroleum ether, chloroform, methanol, water, alcohol, chloroform water of extractive values was determined as per reported methods (Mukherjee PK 2002, Kakate CK 1994, Khandelwal KR 2005) (Table No: - 3).

Phytochemical screening

Qualitative examination of *Morinda citrifolia* bark inorganic matters and determination of heavy metals was done as per reported methods. The dried powdered bark was subjected to preliminary phytochemical screening for qualitative detection of phytoconstituents. The dried powdered bark (100g) was extracted successively hexane, petroleum ether, benzene, benzene, chloroform, acetone, methanol, water in Soxhlet Extractor by continuous hot percolation. Each time before extracting with the next solvent of higher polarity the powdered material was dried in hot air oven below 50^0C for 10 minutes. Each extract was concentrated in vacuum on a Rote Evaporator and finally dried in hot air oven. The dried extracts were dissolved in respective solvents, with it was extracted, and were subjected to various qualitative phytochemical tests for the identification of chemical constituents present in the plant material (Harborne 2005) (Table No: - 4 and 5)

Morphology, Anatomy and Maceration: -

The morphological characters of the trees were studied in detail, and their herbarium sheets were prepared which were preserved in the Herbarium of Department of Botany, Pratishthan Mahavidyalaya, Paithan. Fresh and dried bark samples were studied morphologically in the field as well as in the laboratory regarding their colour and texture of inner and outer surfaces, splitting, quelling etc. The anatomical characters of the barks were taken by free hand sections with the help of blades. Sections were dehydrated with different alcohol grades and stained with safranin and light green. From each bark some sections were unstained while others were double stained. Both unstained and stained sections were permanently preserved. These permanent preparations were observed under microscope (Khandelwal, 2006) and photographed by microphotographic techniques.

The barks were also studied by maceration techniques. The pieces of barks were boiled in Jeffery's fluid (Chromic acid 10% and Nitric acid 10% in 1:1 proportion) the macerated cells were studied in detail (Johanson, 1940; Choudhary *et al.*, 1992 and Khandelwal, 2006). Their figures were drawn with the help of camera lucida and inked by rotring pens. Their photographs were taken by microphotographic techniques. The dimensions of the cells were measured with help of microscope and by micrometry.

Qualitative and Quantitative Analysis: -

Physical evaluation: - Dry matter (DM), Bulk density

Chemical analysis

a. Qualitative: - Tannins, Saponins, Alkaloids, Phenolic acids and flavonoids.

b. Quantitative:- Nitrogen (N), Water soluble nitrogen (WSN), Crude proteins (CP), Crude fats (CFat), Crude fibres (CF), Total ash (TA), Acid insoluble ash (AIA), Acid soluble ash (ASA), Calcium (Ca), Phosphorus (P), Potassium (K), Total carbohydrates (TC), Cellulose, Hemicellulose, Lignins, Reducing sugar, Non reducing sugar, Total sugar, Gross energy (GE) and Extractive values.

RESULTS AND DISCUSSION:

Organoleptic Evaluation: -

The organoleptic characters of *Morinda citrifolia* such as touch, colour, taste, and odour are discussed in (Table No: - 1).

Morphology of bark: -

In Pharmacognosy the term "bark" is used to describe all the tissue found external to the cambium in the branch, stem or root. Barks consist following tissues: - Rhytidoma (dead tissues), cork, Phellogen (meristematic), Phelloderm, cortex and secondary phloem.

Shape and size: - dried bark forms single quelling, curved or channel shaped and very hard, varies in length, 13-19 cm in width and thickness of fresh bark is 13-29 mm and thickness of dried bark is 9-13 mm.

Outer Surface: - Outer surface of younger stem bark is ash in colour, circular to irregular shape dots. Older stem bark is silver to light ash, circular to irregular shape dots are presence in a large number, dots are ash in colour and small in size.

Inner surface: - Inner bark surface is yellowish to creamy in colour, smooth, fibrous and astringent in taste.

Fracture: - Hard, outer is granular, inner is splintery.

Taste: - astringent.

Odour: - Odorless.

Bark quelling is single and half channel shape.

Anatomy of Bark: -

T.S. of bark show 4-5 layers of cork region, outer cork single layer brown in colour 6-10 x 4-7µ square to barrel in shape, dead cells. Inner cortex show 3-4 layers, barrel to rectangular in shape 10-23 x 8-14µ. Cork follows by cortex 15-17 layers circular, oval to rectangular in shape 10-25 x 8-

14µ. Outer cortex contain elongated cells 14-30 x 7-9µ, some secondary metabolism cells presence 3-5 layers. Middle cortex 6-8 layers compactly arranged half rounded to barrel in shape 14-25 x 9-15µ, rounded shape tanniferious cells are observed 10-12 x 9-11µ. Some parenchyma cells are containing cells grain elongated to rectangular shape 9-13 x 5-8µ. Inner cortex contain rounded, oval to rectangular shape 12-17 x 7-11. Parenchyma starch and tanniferious cells are observed in this region. Cortex follow by medullary rays are arrange vertically and arranged in group I to V shape. Medullary rays are single walled, thin, 6-9 x 4-6µ in between two medullary rays group compactly arranged simple parenchyma cells, stones cells, tanniferious cells, parenchyma, starch grain cells, sieve elements and phloem cells. Simple parenchyma attached to medullary rays, rectangular in shape 8-14 x 9-16µ. Stone cells are arranged in between simple parenchyma cells, square in shape 14-21 x 12-16µ. Tannifreious cells are arranged below simple parenchyma and stone cells, oval to square shape 8-12 x 6-9µ. Parenchyma starch grain cells are spared in this region, elongated to rectangular shape 10-19 x 8-11µ. Sieve elements are rhombus in shape 10-14 x 8-11µ. Below the medullary rays double walled phloem fibres are arranged vertical 6-9 x 4-7µ, rounded to hexagon in shape.

Maceration of Bark

Four types of fibres; one is broad, thick, single walled, arranged several cells, rectangle to square in shape, pointed at single side only, cells shows yellow inclusion, measuring from 330-380 x 9-14µ; second is broad, thick, single walled, arranged by several cells, rectangle to square in shape, both sides are without point, measuring from 270-300 x 15-20µ; third is very broad or big in size, arranged by 4-5 cells, oval, square to rectangle in shape, thick, single walled, cells show small spores, pointed at both the ends, measuring from 15-28 x 320-360µ; forth is linear, thin walled, divided into several parts, parts are elongated to rectangle in shape, measuring from 550-580 x 9-12µ. Four types of parenchyma cells; one is broad in size, thick, single walled, arranged in single line, rectangle to square in shape, measuring from 25-30 x 9-12µ; second is linear in size, oval, elongated to rectangle in shape, thick, single walled, measuring from 30-35 x 10-17µ, with having inter cellular space, arranged in several lines; third is linear to broad in size, full with secondary metabolism, thin, single walled, with having intercellular space, arranged in several lines, measuring from 12-23 x 13-20µ; fourth is broad in size, full with small spores, thin, single walled, with having intercellular space, arranged in several lines, oval, square to rectangle in shape, measuring from 30-35 x 9-14µ. Sieve elements long, broad, pointed at single side, elongated in shape, at pointed side show small spores, at middle show oval to elongated structure, thick, single walled, measuring from 230-270 x 12-17µ.

Behavior of Bark Powder towards some Chemical Reagents

The observations are reported in the table 2.

Physico-Cemical Evaluation

The physicochemical studies and successive extractive values of stem of *Morinda citrifolia are* summarized in table 3 and 4.

Qualitative and Quantitative Analysis: -

Physical evaluation: - Dry matter (DM), Bulk density. Qualitative: - Tannins, Saponins, Alkaloids, Phenolic acids and flavonoids. Quantitative:- Nitrogen (N), Water soluble nitrogen (WSN), Crude proteins (CP), Crude fats (CFat), Crude fibres (CF), Total ash (TA), Acid insoluble ash (AIA), Acid soluble ash (ASA), Calcium (Ca), Phosphorus (P), Potassium (K), Total carbohydrates (TC), Cellulose, Hemicellulose, Lignins, Reducing sugar, Non reducing sugar, Total sugar, Gross energy (GE) and Extractive

values mainly in the stem bark of *Ficus racemosa*. The presences of various phytoconstitutes in various extracts are summarized in Table 4 and 5.

Table: 1 organoleptic characteristic of stem Bark of *Morinda citrifolia*.

parameters	
Condition	Dried
Colour	Outer surface- of younger stem bark is ash in colour, circular to irregular shape dots. Older stem bark is silver to light ash, circular to irregular shape dots are presence in a large number, dots are ash in color and small in size. Inner bark surface is yellowish to creamy in colour, smooth, fibrous and astringent in taste.
Odour	Odourless
Taste	astringent
Texture	Hard, outer is arranged transversely half circular to circular in broad line, lightly split line longitudinally, inner is longitudinally striated, fracture difficult, fracture irregular.
Fracture	Fracture difficult, fibrous, fracture irregular.
Size	Length 15-20 cm Thickness 13-19 mm
Shape	Bark quelling is single and half channel shape.

Table: 2 Reactions of stem bark powder of *Morinda citrifolia* with different chemical reagents.

Sr. No.	**Chemical Reagents**	**Observation**
1	Conc. Sulphuric acid	Reddish Brown
2	Conc. Hydrochloric acid	Dark Red
3	Conc. Nitric acid	Red
4	Picric acid	Dark red
5	Glacial Acetic acid	Dark brown
6	Iodine solution	Light yellow
7	Sodium hydroxide solution (aq. 5%)	brownish
8	Potassium hydroxide solution (aq. 5%)	brownish yellow
9	Ferric chloride solution (aq. 5%)	Yellowish
10	Powder as such	Pale reddish
11	Methanol	Brownish Red
12	10% NaOH	Light brownish red
13	Chloroform	Light red
14	Petroleum ether	Dark brownish
15	Distilled water	Light brownish

Table: 3 Physico-Chemical Properties of *Morinda citrifolia* stem bark.

Sr. No.	**Quantitative Standards**	**%**	**Sr. No.**	**Quantitative Standards**	**%**
1.	Dry matter	44.80	13.	Non-Reducing Sugar	0.90
2.	Bulk Density mg/cm3	184	14.	Total Sugar	3.36
3.	Ash	7.68	15	Crude Fibre	35.76
4.	Acid soluble ash	6.50	16.	Crude Fat	1.29
5.	Acid insoluble ash	1.18	17.	Cellulose	44.41
6.	Water soluble ash	5.12	18.	Hemicellulos	8.60
7.	Water insoluble ash	2.56	19.	Lignin	8.60
8.	Nitrogen	1.43	20.	Tannins	8.84

9.	Water Soluble Nitrogen	0.42	21.	Gross Energy K/cal	3.84
10.	Crude Protein	8.81	22.	Calcium	1.89
11.	Carbohydrates	80.22	23.	Phosphorus	0.450
12.	Reducing Sugar	2.46	24.	Potassium	0.321

Table- 4: Successive Extractive Values of the stem Bark of *Morinda citrifolia*.

Sr. No.	Solvent	Weight of Drug	Average Extractive Value (%)
1	Water	10gm	8.20
2	Methanol	10gm	6.40
3	Alcohol	10gm	2.60
4	Benzene	10gm	3.21
5	Petroleum Ether	10gm	0.90
6	Chloroform	10gm	2.00
7	Acetone	10gm	3.68

Table- 5: Distribution of Phenolic acids and chemical compounds in bark samples

Sr. No.	chemical compounds	Results	Sr. No.	chemical compounds	Results
1.	Vanillic acid	+	12.	Saponins	+
2.	Syringic acid	+	13.	Iridoids	-
3.	Ferulic acid	-	14.	Quercetin	-
4.	Protocatechuic acid	-	15.	Kaempferol	-
5.	*p*-hydroxybenzoic acid	-	16.	Catechin	-
6.	*p*-coumaric acid	+	17.	Coumarin	-
7.	Phloretic acid	-	18.	6,7-Dimethoxy coumarin	+
8.	Melilotic acid	+	19.	5-Methoxy genistein	-
9.	Tannins	+	20.	Anthocyanin	-
10.	Phenols	+	21.	Proanthocyanin	-
11.	Alkaloids	-			

The present investigation provides a comprehensive pharmacognostic evaluation of *Morinda citrifolia* L. bark through organoleptic, morphological, anatomical, physicochemical and phytochemical analyses. Such standardization parameters are essential for correct identification and quality control of crude drugs, particularly in medicinally important plants like *M. citrifolia* (Kharate et al., 2024).

Organoleptic and Morphological Characteristics

The bark exhibited characteristic organoleptic properties including ash to silver-grey outer surface, yellowish to creamy inner surface, astringent taste and absence of odour. The presence of circular to irregular dots on the outer surface and fibrous fracture are important macroscopic diagnostic characters. In pharmacognosy, bark includes tissues external to the vascular cambium, comprising cork, phellogen, cortex and secondary phloem (Esau, 1965).

The quilled, half-channel shaped bark with distinct transverse markings and longitudinal striations provides distinguishing features useful in crude drug authentication. These findings are consistent with earlier taxonomic and anatomical descriptions of *M. citrifolia* (Chan-Blanko et al., 2004; Awari and Gampawar, 2023).

Anatomical Characteristics

Transverse sections revealed a well-developed cork region (4–5 layers), followed by cortex and secondary phloem. The presence of tanniferous cells, stone cells (sclereids), starch grains, medullary rays and phloem fibres are key diagnostic markers. Stone cells arranged between

parenchymatous tissues provide mechanical strength and are commonly reported in Rubiaceae members (Esau, 1965). Tanniferous cells observed in cortex and phloem regions correlate with the high tannin content (8.84%) reported in quantitative analysis. Maceration studies revealed four distinct types of fibres and multiple parenchymatous cell forms. The presence of thick-walled fibres (330–380 µm length) and elongated sieve elements confirms the structural adaptation of bark for conduction and mechanical support. Johanson (1940) emphasized that maceration techniques are particularly useful in separating individual elements for micrometric analysis, which supports the reliability of the present findings. The anatomical features observed in this study are in agreement with earlier histochemical investigations on *Morinda citrifolia* (Kharate et al., 2024), confirming its taxonomic authenticity.

Behaviour of Bark Powder with Chemical Reagents

The bark powder showed characteristic colour reactions with concentrated acids and alkalis. The reddish-brown coloration with concentrated sulphuric acid and dark red with hydrochloric acid suggest the presence of phenolic compounds and tannins. Ferric chloride produced yellowish coloration, indicating phenolic constituents. Such powder analysis is useful in crude drug standardization and detection of adulterants (Mukherjee, 2002).

Physico-Chemical Evaluation

Physicochemical parameters serve as quality control standards for herbal drugs. Total ash (7.68%) indicates total inorganic content, while acid insoluble ash (1.18%) represents siliceous matter. Low acid insoluble ash suggests minimal contamination with earthy material. High carbohydrate content (80.22%), cellulose (44.41%), and crude fibre (35.76%) reflect the fibrous nature of bark tissue. Tannin content (8.84%) substantiates the astringent taste and therapeutic potential of the bark. Mineral analysis revealed presence of calcium (1.89%), phosphorus (0.450%) and potassium (0.321%), indicating nutritional significance. These values fall within acceptable pharmacognostic limits for medicinal bark drugs (Khandelwal, 2005).

Extractive Values

Successive extractive values showed maximum solubility in water (8.20%) followed by methanol (6.40%). This indicates predominance of polar phytoconstituents such as phenolics, tannins and glycosides. Petroleum ether showed lowest extractive value (0.90%), indicating minimal non-polar constituents. The higher aqueous extractive value aligns with previous reports emphasizing water-soluble bioactive compounds in *M. citrifolia* (Wang et al., 2002; West et al., 2018).

Phytochemical Screening

Preliminary phytochemical screening confirmed the presence of: Tannins, Phenols, Saponins, Vanillic acid, Syringic acid, p-Coumaric acid, Melilotic acid ,6,7-Dimethoxy coumarin Absence of alkaloids, iridoids, flavonoids such as quercetin and kaempferol suggests variability in phytochemical composition depending on plant part and geographical distribution. Phenolic acids such as vanillic and syringic acid contribute to antioxidant and anti-inflammatory properties (Jian et al.; West et al., 2018). Coumarin derivatives are associated with antimicrobial and anticoagulant activities. The predominance of tannins and phenolic compounds supports earlier reviews describing antioxidant, immunomodulatory and therapeutic benefits of *Morinda citrifolia* (Mohammad Ali et al., 2016; Hardeep Kaur et al., 2018; Chan-Blanko et al., 2004). The integration of anatomical, physicochemical and phytochemical parameters establishes a standard pharmacognostic profile for *Morinda citrifolia* bark, contributing to authentication and prevention of adulteration.

CONCLUSION:

The present study provides a detailed pharmacognostic evaluation of *Morinda citrifolia* L. bark through morphological, anatomical, maceration, physicochemical and phytochemical analyses.

Distinct diagnostic characters such as:

- Quilled bark morphology
- Presence of stone cells and tanniferous cells
- Thick-walled fibres revealed through maceration
- Characteristic powder reactions
- High aqueous extractive value
- Abundant phenolic and tannin content

confirm the authenticity and medicinal potential of the bark.

The predominance of phenolic acids and tannins correlates with the reported antioxidant, anti-inflammatory and therapeutic activities of *M. citrifolia*. The maceration technique proved effective in isolating structural elements for microscopic analysis, strengthening anatomical authentication. This study establishes baseline standards for quality control and pharmacognostic standardization of *Morinda citrifolia* bark. The findings will be valuable for herbal drug formulation, further phytochemical isolation studies and future pharmacological investigations. Further studies involving advanced chromatographic techniques (HPLC, GC-MS) and bioactivity-guided fractionation are recommended to isolate and characterize active constituents responsible for its therapeutic properties.

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