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Pharmacognostical and phytochemical studies of *Mollugo nudicaulis* Lam.: A controversial plant origin ayurvedic drug

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Abstract

Mollugo nudicaulis Lam. of Molluginaceae is an important medicinal plant widely distributed throughout India, Pakistan and tropical Africa. The whole plant is used in the preparation of an Ayurvedic drug-Parpataka, which is controversial, as a good number of plants are used as Parpataka in different regions of India. The present communication deals to authenticate the species of *M. nudicaulis* through macroscopical, microscopical, preliminary phytochemical, physicochemical, fluorescence, and HPTLC studies. Microscopical studies of the root revealed the presence of 4 to 5 layered cortex with parenchyma cells. The xylem observed in tetrarch condition with no growth rings. The fibres are narrow and vessel elements noticed with short tails. The leaf was characterized with well differentiated mesophyll into palisade and spongy parenchyma cells. The vascular bundle was single, conjoint, collateral and top shaped. The calcium oxalate crystals were noticed abundantly in the mesophyll and druses in spongy mesophyll. The stomata were noticed as anomocytic type. Physicochemical values were recorded as; total ash (1.094 %), water-soluble ash (1.46 %), alkalinity of water soluble ash (0.328 ml) and acid insoluble ash (1.64%). The preliminary phytochemical screening revealed the existence of steroids, tannins, phenols, anthraquinones, alkaloids, flavonoids, terpenoids, coumarins and quinones in two solvent systems. The screenings of HPTLC showed the occurrence of noteworthy phytoconstituents with R_f values. The pharmacognostical screening of *M. nudicaulis* is very beneficial for the comparison, authentication of the original drug and to maintain the quality and purity of the plant material used in various Ayurvedic formulations.

1. Introduction

'Parpataka' is an important drug, used in the Indian systems of medicine (ISM). It is one of the prominent drugs in Ayurveda, which is mainly used to treat fevers. The drug is bitter, diuretic, digestive, anthelmintic and relieves constipation (Nadkarni, 1996). The drug is used in the management of *Rakta Pitta* (hemorrhage), *Brama* (giddiness), *Trishna* (thirst) and *Daaha* (burning sensation) (Lakshmipati, 1973).

The therapeutic value of the 'Parpataka' plant has been reported by many workers. The whole plant is considered as pectoral, used in muscular atrophy and whooping cough (Kirtikar and Basu, 1987). The plant leaves are applied externally to remove the pus from boils (Anonymous, 1962; Yoganarasimhan, 2000). The grounded leaves alongwith garlic and pepper is consumed internally to treat polydipsia (Sudarsanam, 1987).

Despite of its multiple uses, the drug is somewhat controversial in identity because in practice many plants are used and marketed with the same name 'Parpataka' in various local markets of the country. As per the Ayurvedic Formulary of India, the accepted source of the drug is *Fumaria indica* (Hassk.) Pug. (Anonymous, 1978). The other plants which are used as Parpataka are; *Glossocardia bosvallea* (L.f.) DC., *Polycarpaea corymbosa* (L.) Lam., *Rungia repens* (L.) Nees., *Glinus oppositifolius* (L.) Aug. DC., *Hedyotis corymbosa* (L.) Lam., and *Mollugo cerviana* (L.) Ser. (Chunekar, 1999; Bapalal, 1985).

It was found during the search of crude drugs from local market of Tirupati that a single medication locally called as 'Parpatakamu' (Telugu) was frequently used as a 'Parpataka' by traditional Ayurveda and Siddha practitioners at different places of South India. The drug was botanically identified as *Mollugo nudicaulis* and the same has further been confirmed by local Ayurvedic Physicians, who used it as 'Parpataka'. The plant is found to be quite different from earlier reported species of 'Parpataka'.

To the best of our knowledge, no pharmacognostical work has been carried out on *M. nudicaulis*. Considering the importance of the species, the present pharmacognostical study was carried out to identify the local market sample of 'Parpataka' on the basis of macro, microscopic and physicochemical parameters, so that the drug could be differentiated from the other reported botanical sources.

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2. Materials and Methods

2.1 Plant collection and identification

The healthy plant material of *M. nudicaulis* was collected from Sri Venkateswara University (SVU) campus, Tirupati, Andhra Pradesh. The specimen was identified and authenticated by local and regional floras (Gamble, 1936; Rangacharyulu, 1991). The herbarium of voucher specimen (Field Book No.: G.S. 1990) submitted in the Department of Botany, S.V. University for future reference.

2.2 Macroscopic examination and organoleptic properties

The plant of *M. nudicaulis* was visually examined for macroscopic characters. The organoleptic properties such as odour, colour, touch and taste of the plant material was observed and noted as per standard procedure (Johansen, 1940; Pratap *et al.,* 2014-2; Jyothi *et al.,* 2020; Kumari *et al.,* 2020).

2.3 Anatomical evaluation

The anatomical evaluation of root and leaf was done by using the standard process of sectioning, powder microscopy, maceration, leaf clearing and venation studies (Johansen, 1940; Jyothi *et al.,* 2020; Pratap *et al.,* 2014-1).

2.4 Physicochemical studies

The physicochemical studies were assessed as per standard methods on the basis of ash values, extractive values in different solvents and calculating the weight loss on drying (Pratap *et al.,* 2014; Kumari *et al.,* 2020, Pande *et al.,* 2018; Jyoti *et al.,* 2018; Yadav and Singh, 2018)

2.5 Fluorescence studies

The fluorescence studies were done by treating the plant material with different reagents followed by observation in terms of color changes under visible light and UV chambers (Jyothi *et al.,* 2020; Pratap *et al.,* 2014-2; Kumari *et al.,* 2020).

2.6 Preliminary phytochemical studies

The powdered plant material was subjected to different types of analytical test for the identification of secondary metabolites like; alkaloids (Dragendorff's and Mayer's tests), triterpenes (Libermann Burchard's test), flavonoids (Aluminium chloride test), anthraquinones (Borntrager's test), polyphenols (Ferric chloride test), sterols (Salkowski's test), coumarins (Lactone test), saponins (Foam test) and tannins (Gelatin test) (Harborne, 1973; Jyoti *et al.,* 2018; Ngameni *et al.,* 2013; Pande *et al.,* 2018; Pratap *et al.,* 2014; Pratap *et al.,* 2012; Poumale *et al.,* 2013; Wansi *et al.,* 2013; Yadav and Singh, 2018)

2.7 Procedure for HPTLC analysis

Alcoholic extract of the powdered drug was used for thin-layer chromatography using a solvent system; toluene: ethyl acetate (6:4), which was saturated for 45 min in CAMAG® Flat Bottom Chamber of 10 x 10 cm. The extract was applied manually on TLC silica gel 60 F254 aluminum coated plates (Merck, KgaA, Germany) and run up to 8 cm. These plates were kept in HPTLC instrument Desaga Sarstedt Gruppe (Germany). The plates were observed under ultraviolet (UV) light at 366 nm, 254 nm and daylight. UV cabinet was arranged with imaging and camera set up with remote shooting. The retention factor (R_f), area, the height of the peak of the developed bands were recorded (Pratap *et al.,* 2012; Kumari *et al.,* 2020).

3. Results

3.1 Taxonomy

Mollugo nudicaulis Lam. Encycl. 4: 234. 1797; Wight & Arn. Prodr. Fl. Ind. orient. 43. 1834; Hook.f. Fl. Brit. India 2: 664. 1879; Gamble, Fl. Madras 1: 553 (390). 1919; Matthew, Mat. Fl. Tamil Nadu Carnatic 225. 1981 & Ill. Fl. Tamil Nadu Carnatic t. 311. 1982.

M. nudicaulis is an erect annual herb. The leaf is radical, spathulate, 4 × 2-4 × 1-2 cm, membranous, glabrous, base attenuate, margin entire, apex retuse-obtuse, petiole up to 1 cm. Flowers white, in many peduncled, polychasial cymes arising from the base. The length of peduncle is up to 8 cm. The branches are leafless, angular, bearing membranous bracts at the nodes, bracts up to 1 mm, pedicel up to 4 mm. Flowers 3 mm, across. Sepals 5, white, elliptic, 3 mm, hooded. Petals are absent. Stamens 3-5, filaments up to 1.5-2 mm. Ovary oblong, 3 lobed, 3-celled, styles 3, capsules ellipsoid, or nearly globose, up to 2 mm brown, seeds many, black, reniform, granular (Figure1).

3.2 Macro characters of root

The roots are long, light cream colored with few lateral roots which can be broken easily (Figure1). The odor was pleasant and slightly bitter in taste (Table 1).

Table 1: Powder characteristics of the whole plant of *M. nudicaulis*

Colour	Appearance	Odour	Taste
Pale brown	Fine powder	Agreeable odour	Slightly bitter

3.3 Microscopical characters of root

Transverse section (T.S.) of the root showed periderm, cortex and large vascular cylinder (Figure 2.1).

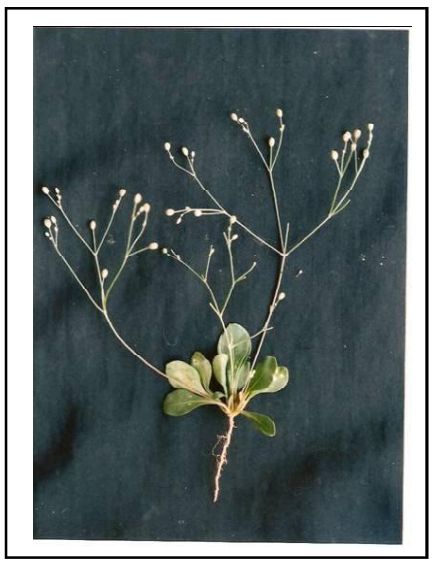

Figure 1: *Mollugo nudicaulis* Lam.

Periderm is 2 to 3 layered; cortex is made up of 4 or 5 layered parenchyma cells. Secondary phloem is thin and continuous. Secondary xylem is nearly 900 µm in diameter. It consists of thin xylem rays of one cell wide, narrow thick-walled vessels and xylem fibres. Vessels are diffuse in distribution; they are circular, mostly solitary or may be in radial multiples, widest vessel is 50 µm in diameter. Xylem fibres are thick walled and lignified. Primary xylem is tetrarch and consists of radial rows of small xylem elements (Figure 2.2).

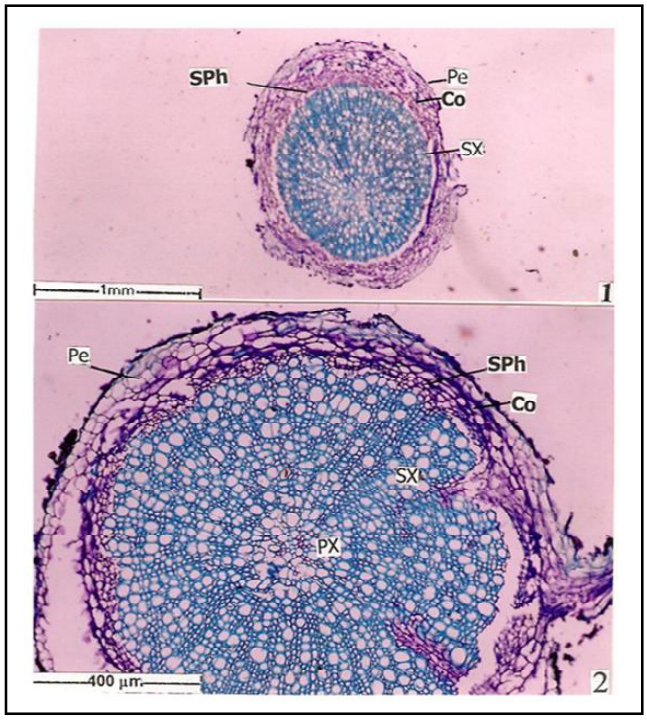

Figure 2: T.S. of root; 1: Microscopical characters of root. 2: T.S. of entire root (enlarged view). Pe: Periderm; Co: Cortex; SPh: Secondary phloem; SX: Secondary xylem; PX: Primary xylem.

Diagnostic characters of root

1. Periderm 2 or 3 layered, not well developed.
2. Cortex in 4 to 5 layered parenchyma cells.
3. Secondary phloem thin and continuous.
4. Xylem-tetrarch condition.
5. Growth rings absent.
6. Presence of narrow elongated fibres and vessel elements with short tails.

3.4 Macroscopical characters of leaf

Leaves radical spathulate, entire, acute 2-3 x 1.2 cm, membranous, glabrous, base attenuate, petiole 1 cm, slightly bitter and smell pleasing.

3.5 Microscopical characters of leaf

Leaf has fairly prominent midrib and uniformly thin, smooth and even lamina (Figure 3). T.S. of the leaf shows the epidermis, mesophyll and vascular bundle. Lateral veins do not project much beyond the leaf surface. Midrib is nearly 650 µm thick in vertical axis. It has a short, blunt adaxial hump and narrowly hemispherical adaxial body. The adaxial midrib consists of compactly arranged thin-walled parenchyma cells. Palisade tissue of the lamina extends as transcurrent band along the adaxial hump. Vascular bundle is single conjoint, collateral and top-shaped. It consists of a cone of xylem elements and thin arc of phloem (Figure 3.2). Vascular bundle is surrounded by a ring of hyaline bundle sheath cells.

3.6 Lamina

It is about 300 µm thick. Abaxial epidermis is made up of different size and shape of cells. Adaxial epidermis also made up of unequal size of cells (Figure 3:1-3). Mesophyll is well differentiated into an adaxial layer of palisade parenchyma and abaxial layer of spongy parenchyma. Palisade parenchyma cells are cylindrical and compactly arranged in a single layer and 90 µm in length. Spongy parenchyma is 4 or 5 layered and loosely arranged (Figure 3.3). Vascular bundle of the lateral vein has a small core of xylem and a phloem mass forming a conjoint, collateral vascular bundle and surrounded by a whorl of bundle sheath cells.

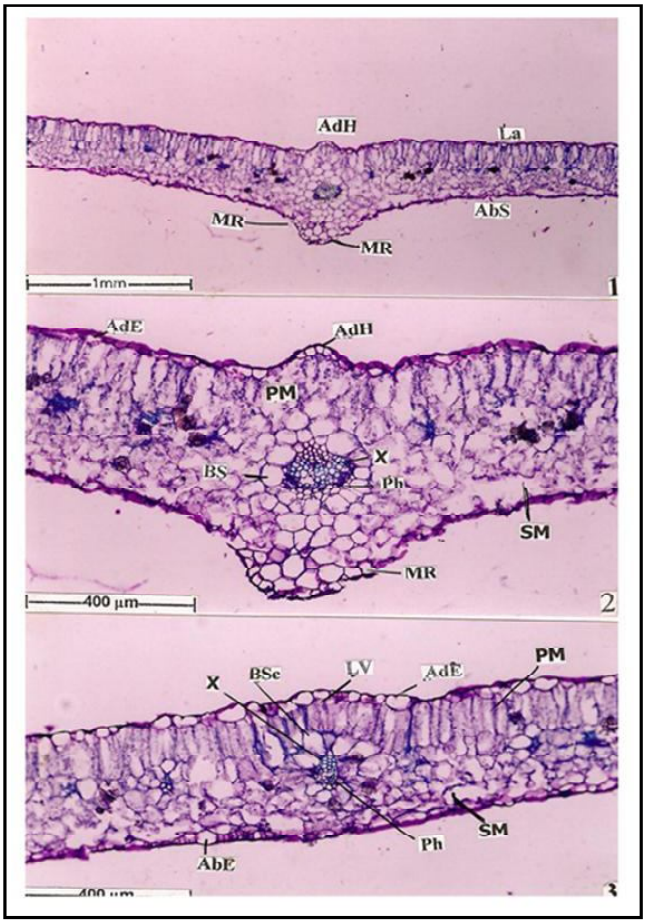

Figure 3: T.S. of the leaf; 1: T.S. of leaf through mid rib with lamina 2: Enlarged midrib 3: T.S. of leaf through lateral vein with lamina. AdH: Adaxial hump; La: Lamina; AbS: Abaxial surface; MR: Midrib; AdE: Adaxial epidermis; PM: Palisade mesophyll; X: xylem; Ph: phloem; BS: Bundle sheath; SM: Spongy mesophyll; LV: Lateral vein; BSC: Bundle sheath cells.

3.7 Crystals

Calcium oxalate crystals abundant in the mesophyll (Figure 4). Crystals are mostly druses, present in the spongy mesophyll (Figure 4:1-3) or in the epidermal cells (Figure 4.3). The druses are up to 50 µm thick. The prismatic crystals are cuboidal or rectangular (Figure 4:2-3).

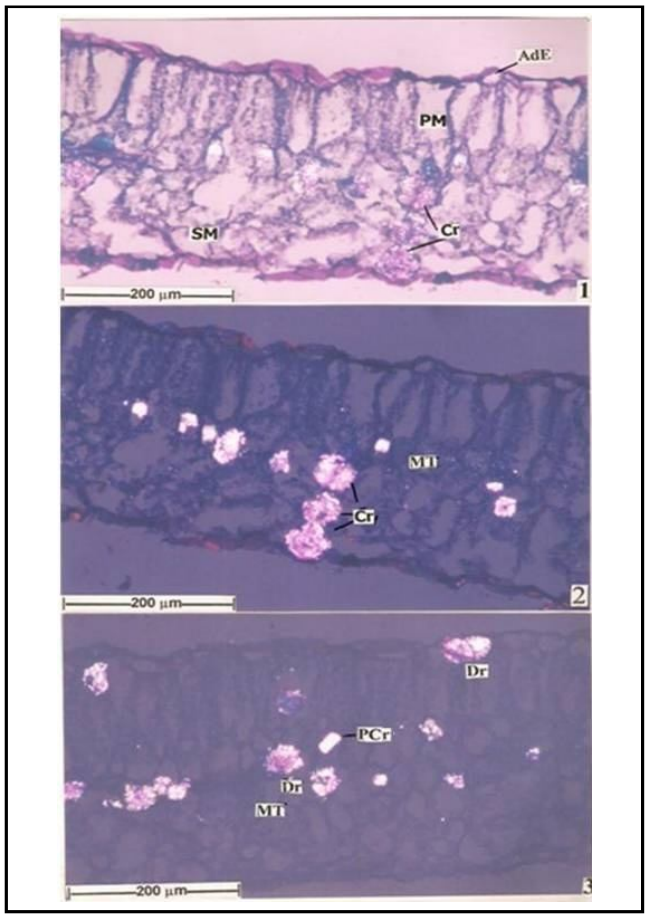

Figure 4: Crystal distribution in mesophyll; 1. T.S. of leaf under bright field microscopy 2-3. T.S. of leaf under polarized light microscope.

AdE: Adaxial epidermis; **PM:** Palisade mesophyll; **SM:** Spongy mesophyll; **Cr:** Crystal; **MT:** Mesophyll tissue; **Dr:** Druces; **PCr:** Prismatic crystals.

3.8 Basal part of the leaf

It has thick, prominent midrib and thick glabrous lamina. Midrib is about 1 mm thick and has prominent adaxial hump and wider, semicircular abaxial part. Ground tissue is homogenous and made up of parenchyma. Vascular strand is arc shaped, conjoint and collateral (Figure 5:1-2).

3.9 Venation pattern

In surface view, the lateral veins and veinlets were found uniformly thin. They form wide distinct vein-islets of varying shape and size. Short or long, thin less prominent vein-terminations are seen in most of the islets. The terminations are unbranched, occasionally forked once at tip. Large druses of calcium oxalate crystals are abundant in the leaf (Figure 6.1).

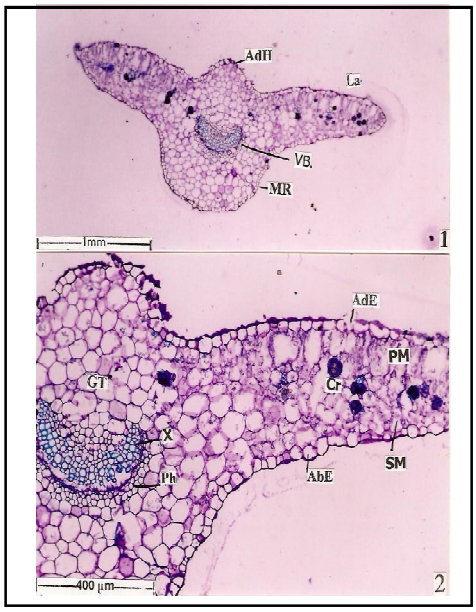

Figure 5: Microscopical characters of basal part of leaf; 1: T.S. of leaf-Entire view 2: T.S. of leaf-an enlarged portion.

AdH: Adaxial hump; **La:** Lamina; **VB:** Vascular bundle; **MR:** Midrib; **AdE:** Adaxial epidermis; **PM:** Palisade mesophyll; **SM:** Spongy mesophyll; **X:** xylem; **Ph:** phloem; **GT:** Ground tissue; **AbE:** Abaxial epidermis; **Cr:** Crystal.

3.10 Stomata

Stomata found on both the upper and lower epidermis. In surface view, the stomata were either elliptical or circular. They were exclusively anomocytic type, lacking distinct subsidiary cells. The epidermal cells are lobed and their anticlinal walls were thin and wavy (Figure 6.2).

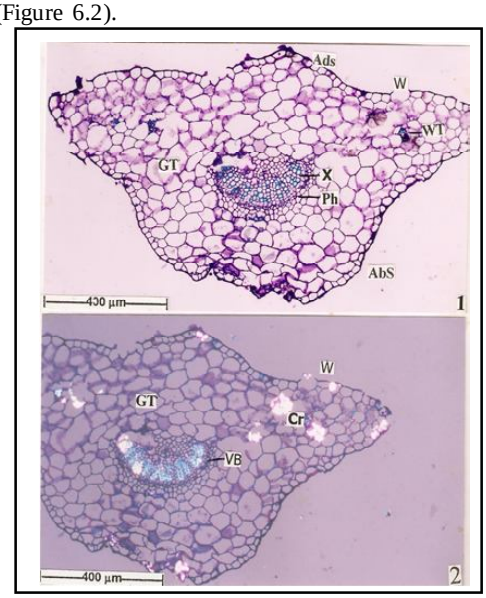

Figure 6: Microscopical characters of the petiole; 1: T.S. of petiole-entire view 2: T.S. of petiole-entire view (under polarized light microscope showing crystals).

AdS: Adaxial surface; **Abs:** Abaxial surface; **W:** Wing; **WT:** Wing tissue; **X:** xylem; **Ph:** phloem; **GT:** Ground tissue; **VB:** Vascular bundle.

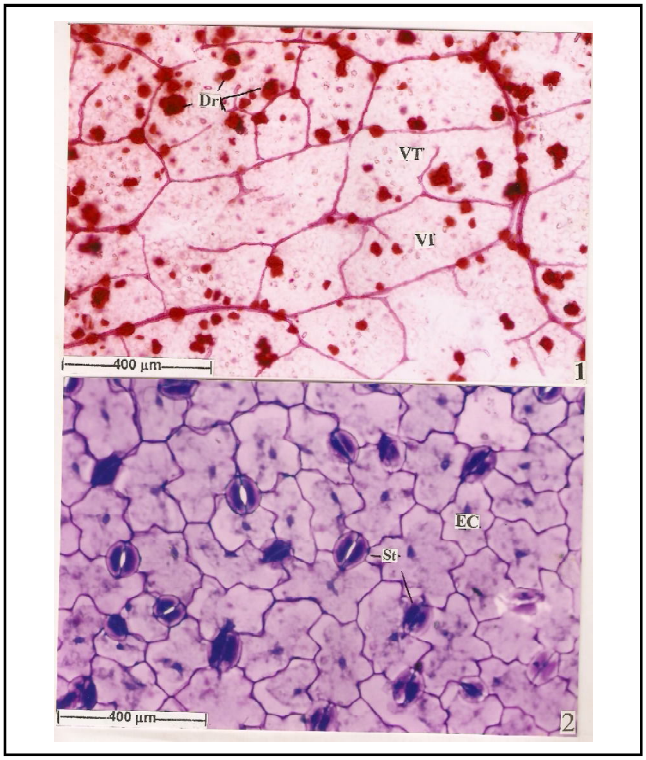

Figure 7: Venation pattern and stomatal morphology; 1: Vein -islets and vein-terminations 2: Abaxial epidermis with stomata.

Dr: Druces; **VT:** Vein-termination; **EC:** Epidermal cells; **St**: Stomata.

3.11 Petiole

It was found thick in the middle with short thick wings (Figure 7.1). It was 750 µm thick in the median part, wings were 250 µm thick. The adaxial part of the petiole is slightly raised and abaxial part is broadly semicircular. Ground tissue of the midrib and wings consists of homogenous, thin walled, compactly arranged parenchymatous cells. Vascular bundle was single collateral, bowl shaped and consists of parallel rows of small angular xylem and a thin arc of phloem. Calcium oxalate druses were observed in the ground tissue as well as in the vascular tissue (Figure 7.2).

Leaf-diagnostic characters

1. Mesophyll well differentiated into palisade and spongy parenchyma cells.
2. Vascular bundle-single, conjoint, collateral and top shaped.
3. Calcium oxalate crystals are abundant in mesophyll.
4. Crystals are of large druses in spongy mesophyll.
5. Presence of anomocytic type of stomata.

3.12 Maceration

The maceration of the whole plant showed the vessel elements narrow with or without tails. The root vessel elements were wider and short, with short tails (Figure 8:1-2) or tailless (Figure 8:3). Stem vessel elements mostly were found mostly tailed and narrow (Figure 8:2). Perforation plates were simple, oblique. Lateral wall pits elliptical and dense; 250- 400 µm long and 25-30 µm wide.

3.13 Fibres

Narrow and wide fibres both were seen, wide fibres showed thin walls, wide lumen up to 280-350 µm long and 20 µm wide. The narrow fibres were found 350-500 µm long and 10 µm wide. In root, only narrow fibres were observed and they were 650-950 µm long and 5 µm wide. The root vessels were 250-500 µm long and 25 µm wide (Figure 8: 1-2).

3.14 Epidermis

The epidermal cells were highly lobed and amoeboid in outline. The cells were fairly thick walled, and stomata were exclusively anomocytic with guard cells 40 x 20 µm (Figure 9:1).

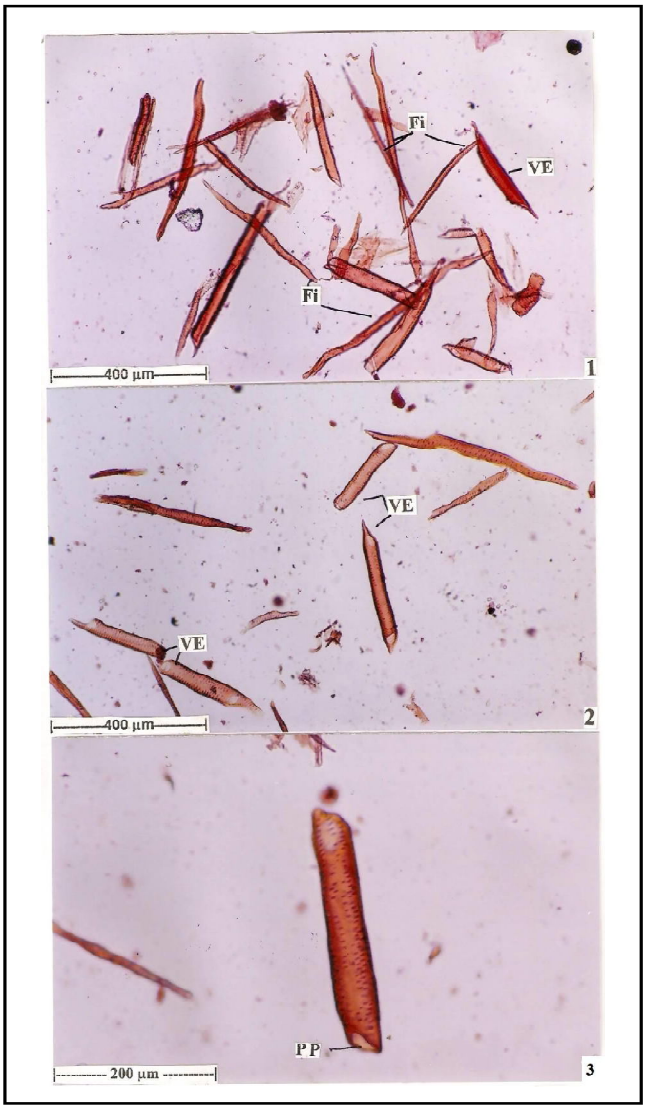

Figure 8: Whole plant macerate; 1: Stem macerate, 2: Root macerate 3: Tailless xylem elements Fi-Fibres; VE-Vessel elements; PP-Perforation plates.

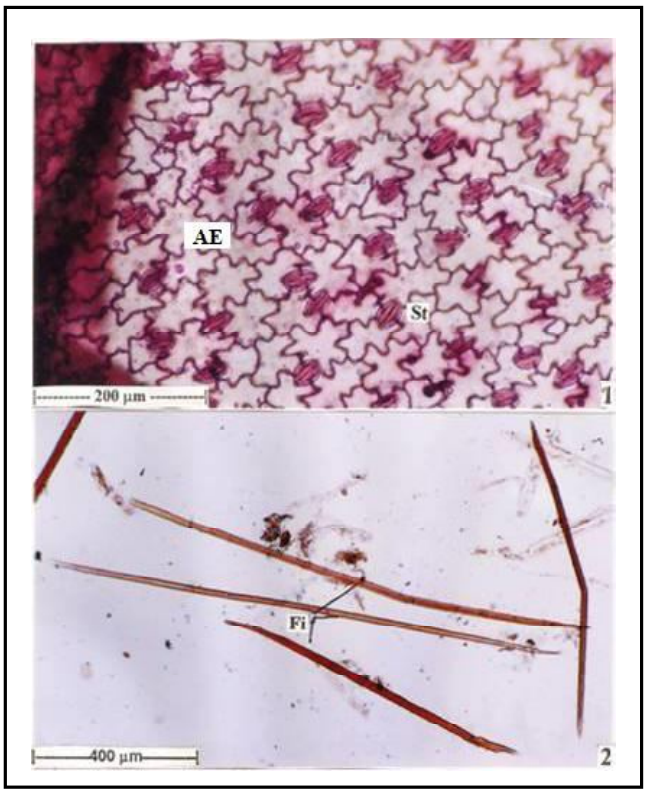

Figure 9: 1-2: Macerates of the whole plant St-Stomata; Fi-fibres; AE-Amoeboid shaped epidermal cells.

3.15 Organoleptic characters

The characters like taste, sight, smell, and touch of the given plant material are summarized in Table 1.

3.16 Powdered drug behavior with different chemical reagents

The powder was treated with normal water and different reagents like NaOH and H_2SO_4. The observations are summarized in Table 2.

Table 2: Powdered drug analysis of *M. nudicaulis*

Treatment	Observation (Whole plant)
Powder treated with water	Non-sticky
Powder shaken with water	Foam like froth
Powder treated with 5% NaOH aqueous	Brown
Powder treated with 60% sulphuric acid (H_2SO_4) aqueous	Reddish brown
Powder pressed between filter paper for 24 hours	No oil stain

3.17 Physicochemical analysis

Ash and extractive values of the drug are summarized in Table 3 and Table 4. It gives an idea of the earthy matter or the inorganic composition and other impurities present along with the drug.

Table 3: Ash values (*M. nudicaulis*)

Total (%) ash	Water soluble ash (%)	Alkalinity of water soluble ash (ml)	Acid insoluble ash (%)
1.94	1.46	0.3282	1.64

Table 4: Extractive values (*M. nudicaulis*)

Alcohol soluble extract (% w/w)	Water soluble extract (% w/w)	Hexane soluble extract (% w/w)	Chloroform soluble extract (% w/w)
1.96	3.09	1.15	0.7833

3.18 Fluorescence analysis

Fluorescence is an important parameter for pharmacognostical evaluation. The phenomenon exhibited by different chemical constituents present in the plant material. Results of the fluorescence analysis of the powdered drug with NaOH, HNO_3, H_2SO_4, $FeCl_3$, picric acid and acetic acid gave different characteristic colour under the ordinary light and ultraviolet (UV) light at 254 and 366 nm. The results of fluorescence analysis are summarized in Table 5.

Table 5: Fluorescence analysis of powdered drug (*M. nudicaulis*)

Experiments	Visible	UV Light	
	Day light	254 nm	366 nm
Drug powder	Pale brown	Pale green	Brown
Drug powder + 1 N NaOH (aq.)	Brown	Black	Black
Drug powder + 1 N NaOH (alc.)	Brown	Yellowish green	Pale green
Drug powder + 1 N HCl	Brown	Black	Black
Drug powder + 50% H_2SO_4	Reddish brown	Yellowish green	Pale green
Drug powder + 50% HNO_3	Orange	Yellowish green	Black
Drug powder + Picric acid	Dark olive (green)	Yellowish green	Green
Drug powder + Acetic acid	Brown	Pale green	Black
Drug powder + Ferric chloride	Dark olive (green)	Pale green	Black
Drug powder + HNO_3 + NH_3	Reddish orange precipitate	Yellowish green	Green

3.19 Preliminary phytochemical studies

The preliminary phytochemical screening was carried out using the methanolic and aqueous extracts of the whole plant to determine the presence of different types of chemical constituents, which are mainly responsible for various therapeutic effects. Therefore, the extracts were analyzed for detection of alkaloids, flavonoids, terpenoids, steroids, tannins, phenols, anthraquinones, coumarins and quinones in two solvent systems. Presence and absence of different phytoconstituents are summarized in Table 6.

Table 6: Qualitative phytochemical screening of methanol and aqueous extracts of the whole plant of *M. nudicaulis*

Name of the Compound	Alkaloids	Flavonoids	Terpenoids	Steroids	Tannins	Phenols	Anthraquinones	Coumarins	Quinones
Aqueous extract	+	-	+	-	-	+	-	+	+
Methanolic extract	+	+	+	+	+	+	+	+	+

3.20 HPTLC profile

Leaf and root extracts of the samples were spotted in triplets on the silica gel "G" plate shown in the figures. These plates were developed using the mobile phase as: Toluene: Ethyl acetate (6:4). Various spots were identified under UV light at 366 nm, 254 nm and visible light (Figures 10 and 12). Different R_f values are summarized in the Tables 7 and 8. The densitograms were developed for the leaf and root powders of *M. nudicaulis* plant (Figures 11 and 13).

TLC studies of the leaf powder showed ten major spots under UV light (366) nm with the R_f values as; 0.04, 0.22, 0.33, 0.39 (All blue), 0.47 (light blue), 0.55 (red), 0.63, 0.66, 0.90 (All blue), 0.93 (red). While under UV light (254 nm) showed four spots with the R_f values as; 0.04 (black), 0.22 (blue), 0.33 (green), 0.63 (light blue). Three spots with R_f values: 0.04, 0.22, 0.33 (All yellow) were found under iodine vapours.

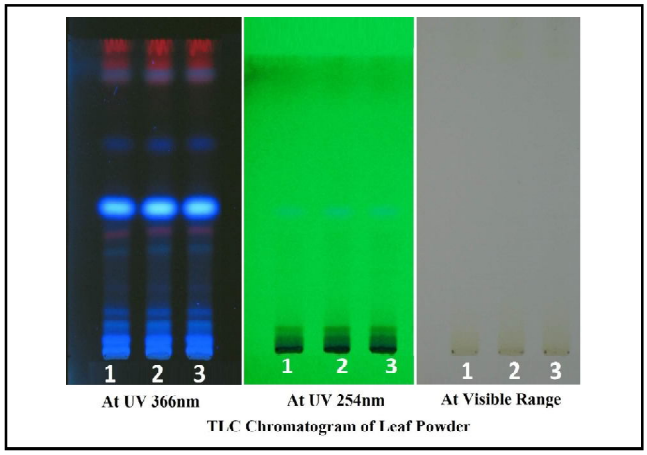

Figure 10: TLC chromatogram of the leaf powder.

TLC studies of the root powder showed ten major spots under UV light at 366 nm with the R_f values as: 0.00 (brown), 0.09, 0.16, 0.21, 0.27, 0.43, 0.56, 0.64, 0.75, 0.88 (all red), 0.47 (light blue), 0.55 (red), 0.63, 0.66, 0.90 (all blue), 0.93 (red). While, under UV light at 254 nm showed five spots with R_f values as; 0.00, 0.21, 0.27, 0.88 (all black). Eight spots with the R_f values (0.00, 0.09, 0.21, 0.27, 0.35, 0.43, 0.75, 0.88 (all yellow) were observed under iodine vapours.

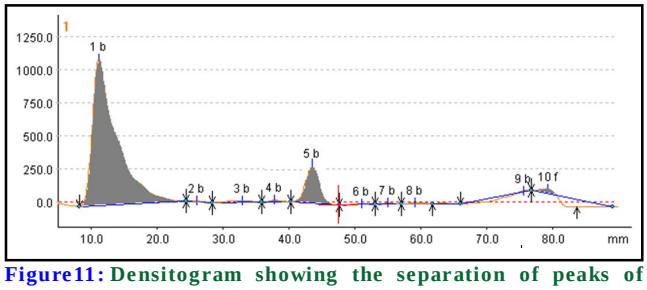

Figure11: Densitogram showing the separation of peaks of leaf powder.

TLC plates were subjected to the HPTLC instrument to record the densitograms, in which different peaks were observed for the spots that appeared in the TLC plates. Each peak area was recorded and the corresponding data for peak areas as detected in HPTLC densitogram are presented in Figure 11 and Figure 12.

Table 7: Peak list and densitogram of leaf powder of *M. nudicaulis* at 366 nm UV light with R_f values of the spots

Peak No.	Y Pos	Area	Area (%)	Height (mm)	R_f values
1	11.3	4574.87	89.1	1087.01	0.04
2	26.3	7.94	0.2	4.52	0.22
3	33.1	53.36	1.0	13.6	0.33
4	37.9	26.23	0.5	12.25	0.39
5	43.5	369.85	7.2	128.73	0.47
6	51.3	17.8	0.3	6.47	0.55
7	55.2	10.74	0.2	6.04	0.63
8	59.3	8.90	0.2	3.72	0.66
9	75.5	10.62	0.2	7.91	0.90
10	79.4	76.74	1.5	35.60	0.93

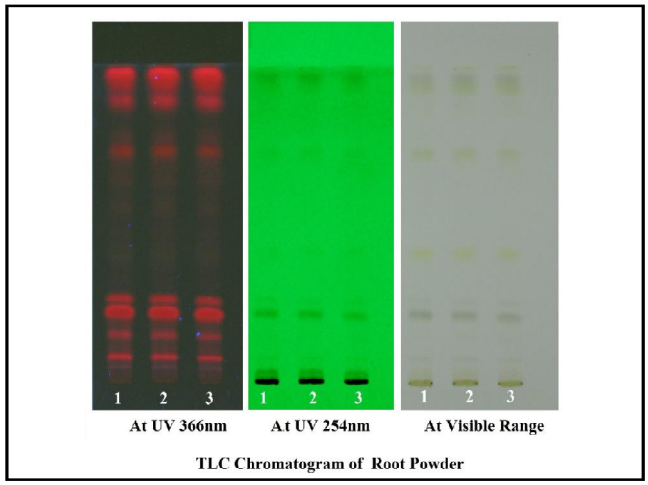

Figure 12: TLC chromatogram of the root powder.

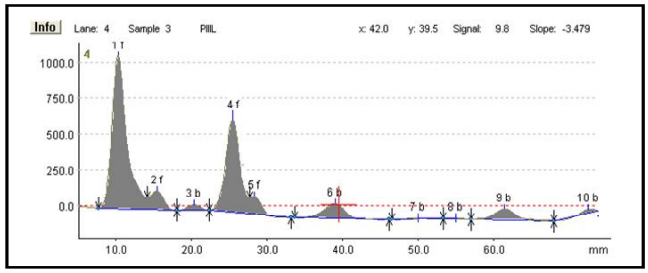

Figure 13: Densitogram showing the separation of peaks of root powder.

Table 8: Peak list and densitogram of root powder of *M. nudicaulis* at 366 nm UV light with R_f values of the spots

Peak No.	Y Pos	Area	Area (%)	Height (mm)	R_f values
1	10.4	2384.69	50.5	1050.93	0.00
2	15.5	265.55	5.6	129.56	0.09
3	20.2	76.23	1.6	37.92	0.16
4	25.5	1161.75	24.8	680.57	0.21
5	28.2	192.15	4.0	124.25	0.27
6	39.1	326.01	6.9	104.76	0.43
7	50.2	21.14	0.5	5.56	0.56
8	55.2	5.0	0.1	2.79	0.64
9	61.4	230.67	4.9	71.98	0.75
10	72.4	51.75	1.1	26.55	0.88

4. Discussion

In the present context, as we know that traditional remedies used in AYUSH systems-Ayurveda, Siddha and Unani, play a vital role in healthcare systems, as these drugs are easily available at low cost, safe and most of the people have faith in them. The ancient Ayurvedic physicians are considered to have developed the different treatment procedure after validating the therapeutic benefits of the medicinal plants/drugs in humans by the 'hit and trial' method, and the success or failure of the cases being discussed with other eminent scholars during the regional gatherings. However, due to lack of established botanical nomenclature system at that time, these plant origin drugs were documented with their Sanskrit names. Later, Ayurvedic scholars from various places appear to have interpreted their botanical identification in different ways. Multiple pharmacological activities attributed to a single plant origin drug may have complicated the practice of determining the correct botanical scientific name (Husain, 2017).

As the usage of these drugs has increased nowadays, issues related to their quality, safety, and efficacy is of great concern. The purpose of pharmacognostical studies and standardization of medicinal plant products (drugs/formulation) is obviously to ensure the therapeutic efficacy of the end product without any adulteration. Therefore, maintaining the quality of the plant origin drug and its products is an essential factor. The observations on different important parameters revealed some specific results for the drug plant, *M. nudicaulis*, which clearly differs from the other botanical sources of Parpataka like; *Peristrophe paniculata*, *Fumaria indica*, *Polycarpaea corymbosa*, *Mollugo cerviana*, *Glossocardia bosvallea* and *Rungia repens* (Jyothi *et al.*, 2020; Jyothi *et al.*, 2019; Jyothi *et al.*, 2010-1; Jyothi *et al.*, 2010-2; Jyothi *et al.*, 2015).

The presence of various phytochemicals in *M. nudicaulis* plant is in agreement with the similar results reported earlier from the other species such as: *Amorphophallus smithsonianus* (Kavalan *et al.*, 2020), *Aegle marmelos* (Tiwari *et al.*, 2016) and *Solanum xanthocarpum* (Bhatt *et al.*, 2019). Nevertheless, in the present study, due to the solubility nature of a large range of polar compounds, methanolic solvent has been used to extract important phytochemicals from *M. nudicaulis* plant. The methanolic extracts revealed the presence of major phytochemicals such as: alkaloids, saponin, tannin and flavonoids as compared to aqueous extracts. The observation is in consonance with an earlier report on the leaves of *Abrus precatorius* (Modi *et al.*, 2018).

HPTLC is an important tool which is used for the standardization of the product by the development of fingerprint profile, quantification of phytoconstituents and determination of impurities. It is being used for both qualitative and quantitative analysis of all range of AYUSH formulations and more specifically the crude drugs. HPTLC analysis and validation of markers compounds plays a major role in standardization of poly herbal formulation (Thakur *et al.*, 2020).

5. Conclusion

The study on *M. nudicaulis* successfully established the pharmacognostical standards of a market sample drug, Parpataka. The morphological, microscopical, physicochemical and chromatographic parameters of this controversial drug would surely help to identify the species and would also be proved to be helpful in determination of its purity and quality standards during the preparation of Ayurvedic formulations. Further, these data could be utilized amicably in evaluation of pharmacopoeial measures and adulteration, in terms quality assurance of drug with cost effective and less time-consuming technique like HPTLC.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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