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Pharmacognostical studies of the flower, leaf, root, and rhizome used for the identification and authentication of *Agapanthus africanus* [L.], cultivated in Egypt

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Abstract

Agapanthus africanus [L.], is a rhizomatous evergreen plant with fleshy roots, linear leaves, and umbellate inflorescence. It is native to southern Africa and commonly named the Nile lily or African lily. Regarding how closely related their morphologies are, the members of the genus *Agapanthus* have proven challenging to divide into distinct species. Additionally, no documentation was detected for the phytochemical screening, macro and micromorphology of *A. africanus* up to date. This inspired us to describe the macro and micromorphology of the flower, leaf, root, and rhizome of *A. africanus* and evaluate its phytoconstituents. This study demonstrated that *A. africanus* is free from any trichomes and is rich with various forms of calcium oxalate crystals, both these characteristics help to define the plant under investigation. Concomitantly, the fibrous layer of the anther, the papillosed stigma, and the ellipsoid, non-spiny pollen grains, were recorded in the morphology of the flower in this study. The phytochemical screening investigated the presence of saponins, phenolics, and flavonoids as the major constituents of the underground parts of *A. africanus*. As expected, this resulted in a more precise tool for taxonomical identification and species delimitation of the genus *Agapanthus*.

Keywords

Amaryllidaceae; *Agapanthus africanus*; Phytochemical screening; Macro and micromorphological studies.

Figure 1. Photo of *Agapanthus africanus* (x .07)

1. Introduction

The Amaryllidaceae plants are herbaceous, mostly perennial, and bulbous or with a rhizomatous stem [1, 2]. Amaryllidaceae is divided into three subfamilies, namely Amaryllidoideae, Agapanthoideae, and Allioideae [3]. Despite having a superior ovary, *Agapanthus* belongs to the Amaryllidaceae family which owns an epigynous ovary, specifically in the subfamily Agapanthoideae [4]. Plants of this genus have fleshy tuberous root systems, and were identified into six species and four subspecies [5]. *Agapanthus africanus* [L] Hoffmanns., was the first member of this genus to be discussed, and it was established by Hoffmannseg in 1824 [6, 7]. Commonly named the Nile lily or African lily, and is a rhizomatous evergreen plant with fleshy roots, linear leaves, and its inflorescence is umbeluated [8, 9]. The zygomorphic, bisexual, trimerous, and superior ovary flowers in this genus are distinctive, while the fruits are loculicidal capsules with winged black seeds [10]. *Abumon africanum*, *Agapanthus minor*, *Agapanthus umbellatus*, *Crinum africanum*, *Mauhlia africana*, and *Tulbaghia Africana* are some of its well-known synonyms [11].

A. africanus is a perennial rhizomatous plant around 60 to 75 cm tall, with fleshy roots, green linear leaves, fairly erect scape, with two cream-green bracts, pseudo-umbel inflorescence and pedicellated, funnel-shaped and light blue to pale violet-coloured flowers [Fig. 1 &2B]. The fruit is an elliptical, three-angled, pendulous capsule with light and shiny green colour, and the seeds are flat, black, and with wings [Fig. 2E] [8]. Furthermore, the inflorescence is enclosed by two bracts that are foliaceous, ovoid in shape with acute apices, cream-green with brown or green longitudinal venation that split vertically, with the upper valve being larger and surviving longer and measuring 2.5 to 3 cm in diameter. But before the complete blooming stages, the two bract valves drop off [8].

A. africanus has been used to assist in the delivery of healthy babies with no bowel problems, the easy delivery of the placenta [12]. Additionally, help in the improvement of memory, and against various disorders particularly in South Africa conventional remedies [13, 14]. The significant isolated

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bioactive secondary metabolites are spirostan saponins and sapogenins [15-20]. The antifungal activity and uterotonic action were the most significant pharmacological activity [18, 21-24].

To date, there has been no published literature of the phytochemical screening, macro and micromorphology of *A. africanus*. As a result, the current study's objective was to characterize the morpho-anatomy of the flower, leaf, root, and rhizome of *A. africanus* and to screen its phytoconstituents in order to highlight identification traits of this plant.

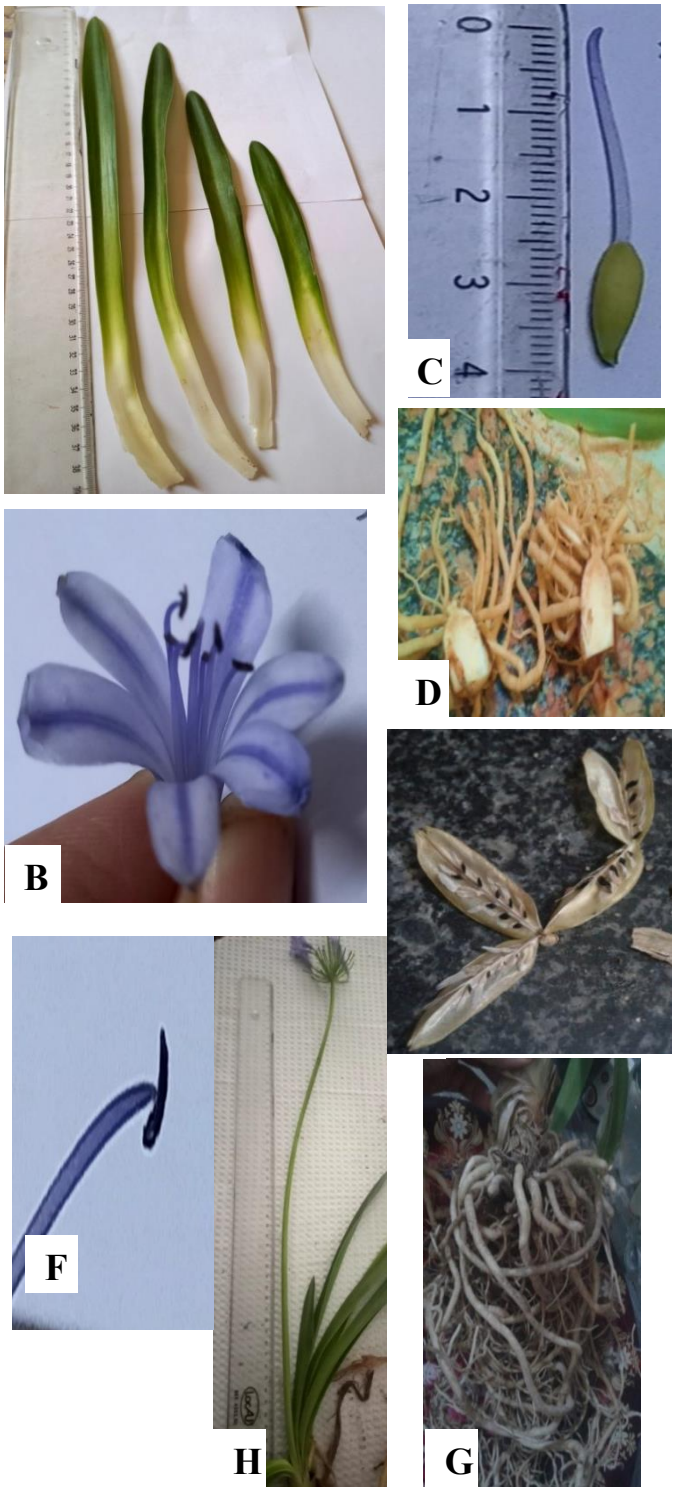

Figure 2. A: The leaves (x 0.2), **B:** The flower (x 1.14), **C:** The gynoecium (x 1.1), **D:** The rhizome (x 0.38), **E:** The capsule and seeds (x 0.8), **F:** The androecium (x 1.56), **G:** The roots (x0.16), **H:** The scape (x 0.14).

2. Materials and methods

2.1. Plant material

The plant material including the flower, leaf, root and rhizome of *A. africanus* [L.] were collected in July 2020 from a local plant nursery, Giza, Egypt, and identified by Prof. Dr Nasser Barakat, Department of botany, Faculty of Science, Minia University. The voucher sample [Mn-Ph-Cog-042] was deposited in the Herbarium of the Pharmacognosy Department, Faculty of Pharmacy, Minia University, Minia, Egypt. The fresh specimens were preserved in a solution of glycerin, distilled water, and 70% ethanol in a ratio of 1:1:1. The various parts of this plant were air dried, fine grinded, and placed in tightly closed containers for microscopic examination.

2.2. Plant extraction

The dried extract was obtained by macerating the air-dried powdered of the underground parts [2 Kg] of *A. africanus*, using 95% methanol [four times each 10 L, overnight], and then filtered and concentrated under vacuum till dryness, yielding 300 g of dried dark brown residue. Rotary flash evaporator, Heidolph™ Condenser G1, Germany, used for concentrating the methanolic extract.

2.3. Leaf preparation

Fresh leaves of the plant were cut into slices and the upper and the lower epidermis were removed using tweezers. The slices were then placed in a petri dish with distilled water to examine the type and distribution of trichomes, stomata and other epidermal characteristics.

2.4. Microscopic characters

Transverse sections [T.S.], longitudinal section [L.S.] as well as the powder of the flower, leaf, root and rhizome were studied microscopically with camera, Leica®, Germany. All significant elements have been identified and appropriately recorded. The plant sections and the powder were stained with safranin and iodine solution.

2.5. Preliminary phytochemical screening

The crude extract of the underground parts of *A. africanus* were subjected to determine their phytoconstituents using standard protocols. The results and the corresponding protocol for each test are listed in Table 2.

3. Result and discussion

3.1. Macroscopic characters

The leaf [Fig. 2A]

It is tufts of simple, sessile and linear leaves, with entire margin, and acute to obtuse apices. The leaf blade is perennial, glabrous, leathery, arising alternately [distichous leaf], showing a parallel venation and having a faint odour and are tasteless. Older leaves were on the outside of newly developing ones, and they measure 36-40 cm in length, 2 cm in width, while the new leaves are around 18-22 cm in length and 1 cm in diameter. The leaves are green in color except the last 5-7 cm from the base are colored white.

The inflorescence [Fig. 1]

It is terminal with pseudo-umbel flowers that are carried on a stiff, greenish to yellowish green and erect to suberect scape. The scape length is about 44-52 cm and 0.5-0.8 cm in diameter at the base. It carries 36-52 open-faced flowers in an umbel.

The flower

The flower is pedicellate, funnel-shaped, glabrous, light blue or pale violet in colour, tasteless, and possesses a faint odour. It is actinomorphic, homochlamydeous, hermaphrodite, trimerous, hypogenous, bracteate, and measures 2.5– 4.2 cm in length with a funnel-mouth diameter of 1.5–3 cm [Fig. 2B].

The perianth:

It consists of 6 delicate segments arranged in 2 alternated whorls and fused to form a perianth tube. The perianth lobes are light blue to pale violet in colour, oblanceolate to spatulate in shape, entire margin, acute to obtuse apices, smooth in texture, measuring 2.5-4.2 cm in length 1-2 mm wide at the base. Dark blue grooves can be seen on the middle perianth lobes.

The androecium:

It is composed of 6 free epiphyllous stamens arranged in 2 wholes with filiform and simple, cylindrical light blue or pale violet filament. The anther is black, dorsifixed, introrse and dehiscing by longitudinal slits. The filament measures 2-2.7 cm in length and 1 mm in diameter. While the anther measures 3 mm in length and 1 mm in diameter [Fig. 2F].

The gynaecium:

The ovary is superior, tricarpellary, trilocular, syncarpous, smooth in texture, yellowish in colour, ovoid in shape and measures 1.5 cm in length and 3-4 mm in diameter. Each locule contains two ovules arranged on axial placentation. The style is cylindrical straight filiform, light blue or pale violet in colour. The style and stigma measure 2-2.2 cm in length and 1mm in diameter, and the stigma is small and slightly curved inwards [Fig. 2C].

The pedicel:

The pedicel is cylindrical, smooth, and green in color and measures 2- 4 cm in length and 1-2 mm in diameter.
The floral formula is expressed as follow:

$\oplus, \overset{\frown}{\varnothing}, P_{(3+3),}\ A_{3+3}, \underline{G}_{(3)}$, **<u>Axial</u> placentation (Fig. 3)**

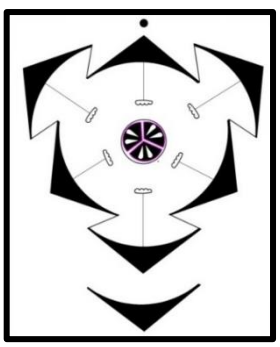

Figure 3. The floral diagram.

Root

The roots have numerous velamen systems and carry lateral rootlets. The roots are white in colour, cylindrical in shape, tasteless, and with a characteristic odour. And when cut they are fleshy and waxy with a smooth surface. They measure 1-2 cm in diameter and 12-27 cm in length [Fig. 2G].

Rhizome

It is short and stiff, growing just under the surface of the ground with one or more shoots and with a mass of fleshy roots. The mature rhizome is from 3-6 cm up to 8 cm in length and is covered with yellowish brown leaf sheaths that provide protection. A transversely cut piece is yellowish white internally and yellowish brown externally. The leaf sheaths were removed to facilitate the morphological examination of the rhizome [Fig. 2D].

3.2. Micro-morphological characters

The leaf [Fig. 4]:

A transverse section in the leaf is slightly convex, showing a glabrous surface and an isobilateral mesophyll that was separated by cortex and vascular tissue in the midrib and laminal regions. The leaf tissues are very rich in various types of calcium oxalate including rhaphids, acicular, aggregate crystals, and clusters [Fig. 7].

Epidermis

The upper [adaxial] and lower [abaxial] epidermis consists of only a single layer of parenchyma cells. The cells of both upper and lower epidermis are rectangular, axillary elongated, and exhibit small projection [papillae] with the lower surface cells exhibiting more prominent projections. The epidermal cells of the upper surface are higher and longer but less wide [narrower] than cells of the lower surface [Table 1]. Both the upper and lower epidermis contained anomocytic stomata that were scattered on both epidermises. However, secretory ducts and glandular or non-glandular trichomes were absent. Both upper and lower epidermises are covered with a thick layer of cuticle and have straight anticlinal walls [Fig. 5].

Upper epidermis

The upper epidermis consists of a single layer of columnar, axillary elongated cells that exhibit small projection [papillae], and covered with a thick cuticle as appearing in the transverse section. However, the epidermal cells in the surface view appear polygonal and somewhat rhomboid-shaped with straight anticlinal walls. The upper epidermis is free from trichomes but exhibiting anomocytic stomata. The stomata are spherical, have wide osteoles, and are encircled by four to five subsidiary cells covered with smooth cuticle.

Lower epidermis

The upper epidermis is formed of a one row of columnar, axillary elongated cells with more prominent projections. The epidermal cells are wider and shorter than the upper epidermis and covered with a thin cuticle as in the transverse section [25].

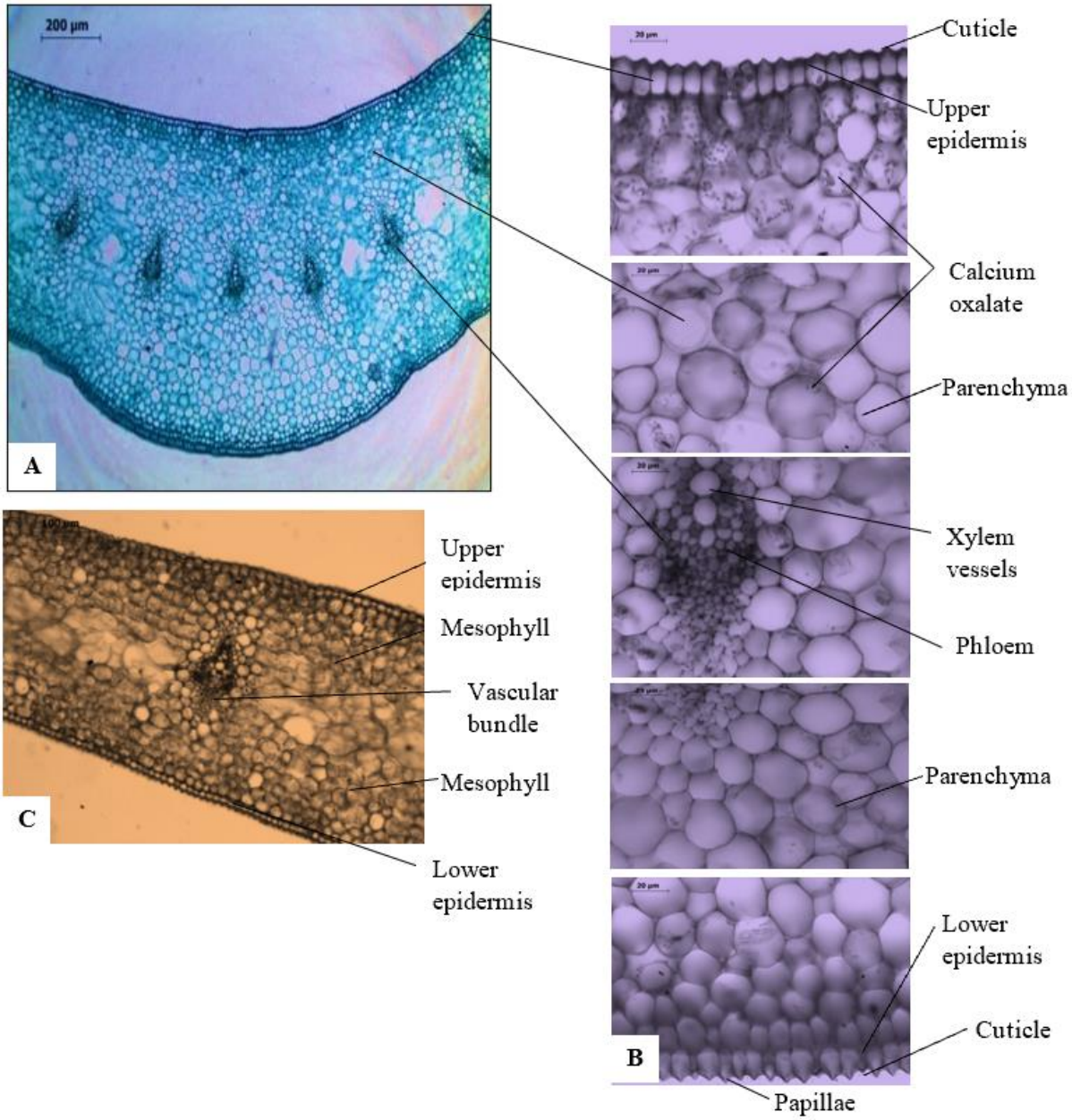

Figure 4. A: T.S of the leaf (x 40), **B:** Detailed T.S. of the leaf in the midrib region (x 400), **C:** Detailed T. S. of the leaf in the lamina region (x 100).

However, the epidermal cells in the surface view appear polygonal, somewhat rhomboid-shaped with slightly wavy anticlinal walls covered with a smooth cuticle showing anomocytic stomata that are more abundant in the lower epidermis than the upper one.

Mesophyll

Instead, mesophyll is composed of rounded parenchyma cells that are dense in chloroplast and have few to no intercellular spaces. Mesophyll does not differentiate into palisade and spongy cells. The parenchyma cells of mesophyll are arranged tightly, in contrast to the loosely arranged, larger gap mesophyll tissue between the V.B especially in the lamina region. The cells of the most outer layer of mesophyll are slightly axillary elongated rather than of the remaining cells.

Vascular bundles

Closed vascular bundles are scattered in both midrib region and leaf lamina and arranged parallel to each other. The midrib shows from 6 to 7 scattered vascular bundles, while there are from 3 to 4 vascular bundles in the lamina region. Phloem is directed toward the lower epidermis, whereas xylem vessels are oriented toward the upper epidermis. The xylem vessels have spiral and scalariform thickenings as shown in the powder [fig. 6A& B]. The bundle sheath is indistinguishable.

The powdered leaf

The powder of the leaf is tasteless, with pale green colour, and a faint odour. The powder revealed the following items:

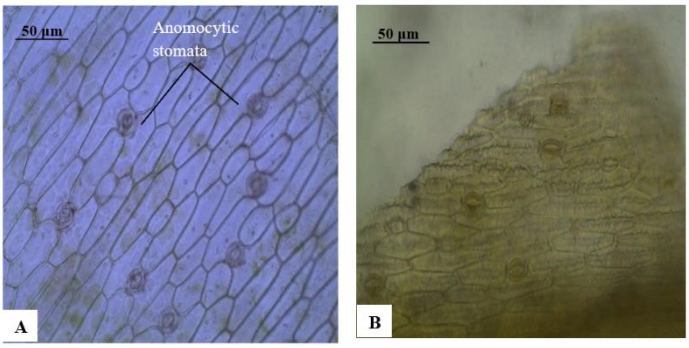

Figure 5. A: Upper epidermis showing anomocytic stomata (x 200), **B:** Lower epidermis (x 200).

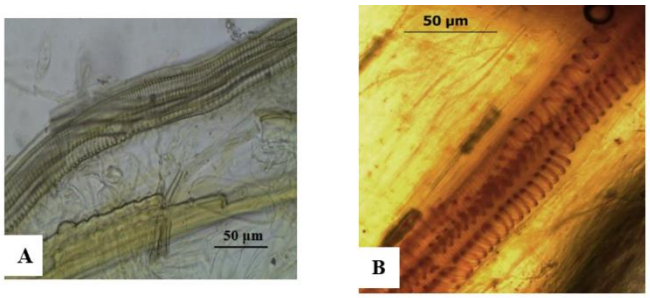

Figure 6. A: Scalariform xylem vessels (x 200), **B:** Spiral xylem vessels (x 200).

A) Fragments of the upper and lower epidermises [Fig. 5].
B) Fragments of lignified xylem vessels with spiral and scalariform thickenings [Fig. 6A&B].
C) Crystals of calcium oxalate including clusters [Fig. 7A], acicular [Fig. 7B], rhaphids [Fig. 7C], crystal aggregates [Fig. 7D].

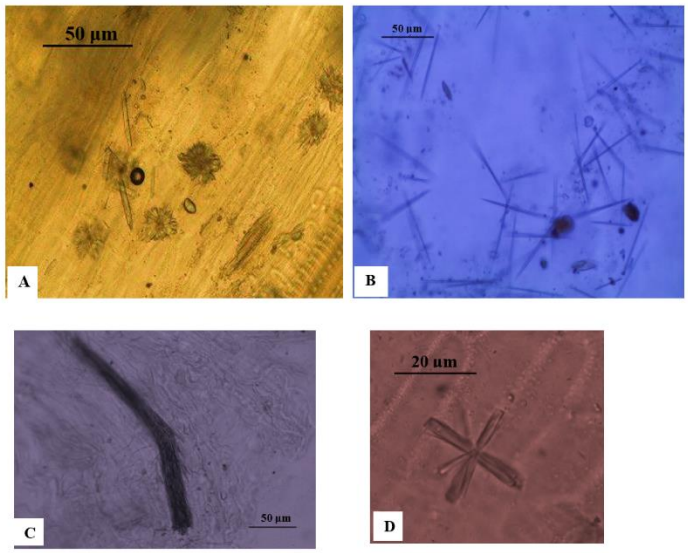

Figure 7: Variations of calcium oxalate in the leaf**: A:** Clusters (x 200), **B:** Acicular (x 200), **C:** Raphids (x 200), **D:** Aggregate crystal (x 400).

The flower

A transverse section of the flower [Fig. 8] reveals six tepals with no trichomes, an androecium of six stamens that consists of two pollen sacs in each anther lobe containing numerous ellipsoid pollen grains and a gynoecium of a superior tricarpellary trilocular ovary with two ovules in each locule attached to an axial placenta.

Flower tepals [the perianth]

According to a transversal section, the upper and lower epidermis layers are comprised of one row of isometric radially elongated rectangular cells covered with a thin cuticle, while in surface view the cells appear polygonal with straight beaded anticlinal walls covered with smooth cuticle and showing anomocytic stomata. The cortex is made up of rounded parenchyma cells arranged in around 10-12 rows, each with thin walls and small intracellular spaces, however the edges of the wings have a smaller mesophyll [6-7 rows]. Air cavities are observed in the cortex of tepal. The vascular tissue consists of a small closed collateral V.B with spiral and scalariform lignified xylem vessels [Fig. 9D] and phloem. And from 1-3 vascular bundles was only present in the midrib region of the tepals [Fig. 9].

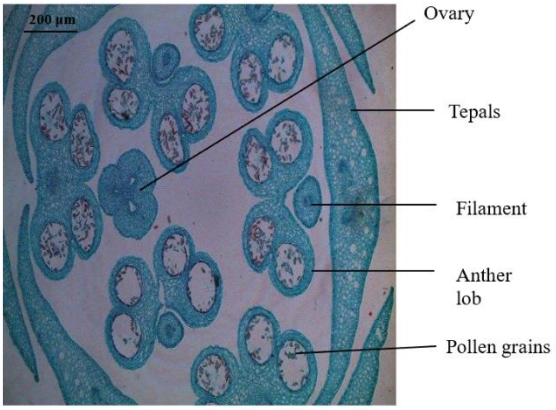

Figure 8. T.S. of the flower (x 40).

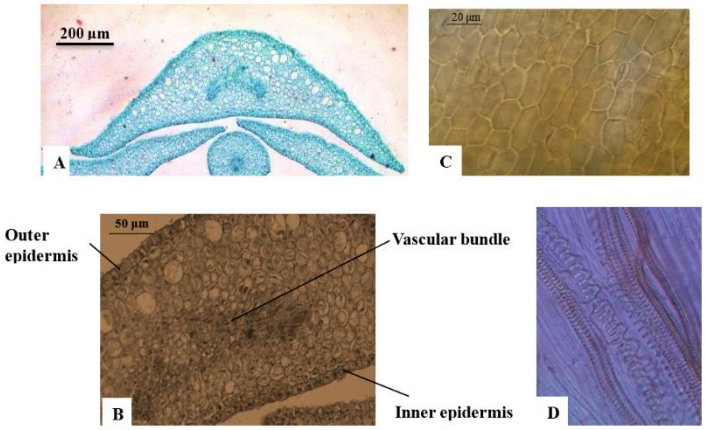

Figure 9. A: T.S. in the tepal (x 40), **B:** Detailed T.S. of the tepal (x 200), **C:** Anomocytic stomata of the tepal (x400), **D:** Spiral and scalariform xylem vessels of tepal (x 200).

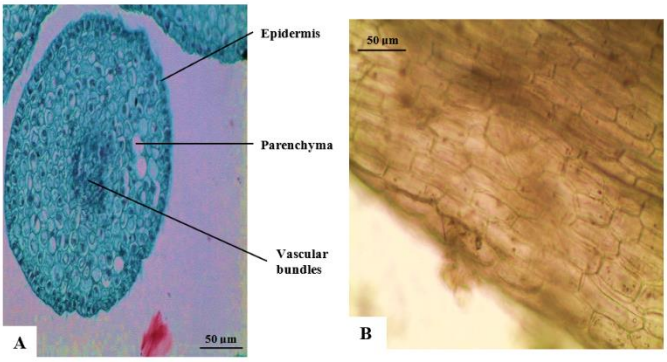

Figure 10. A: T.S of the filament (x 200), **B:** Epidermal tissue of the filament (x 200).

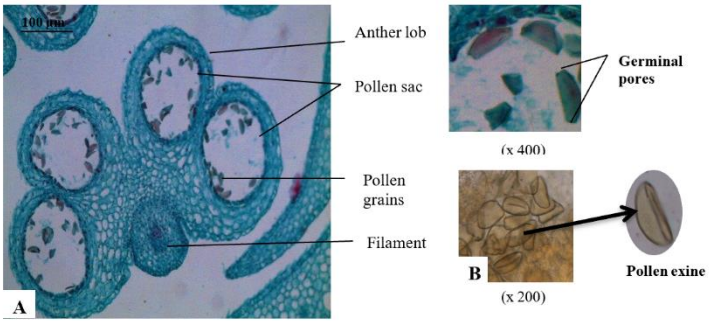

Figure 11. A: T.S. of the anther (x 100), **B:** Pollen grains showing the germinal pores (x 400), pollen exine (x 200).

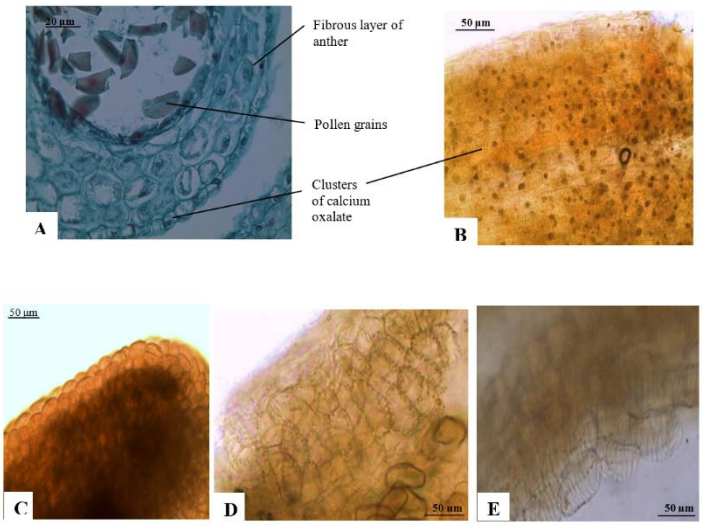

Figure 12. A: Anther lob (x 400), **B:** cluster of calcium oxalate (x 200), **C:** Epidermis of the anther showing papillae (x 200), **D:** Fibrous layer of anther in the top view (x 200), **E:** Fibrous layer of anther in the side view (x 200).

The androecium

The filament

A transverse section in the filament is nearly circular in outline. It shows a sub-rectangular, slightly elongated epidermal cell that encloses a wide cortex and a central vascular bundle. The epidermal cells have straight anticlinal walls and are devoid of stomata and trichomes [Fig. 10].

The anther [Fig. 11 & 12]

The transverse section of the anther shows two anther lobes that are connected by parenchymatous connective tissue [Fig. 11A]. The two anther lobes consist of two pollen sacs and contain numerous ellipsoid pollen grains. A layer of epidermis, a few [1-3] fibrous layers, and secretory tapetum make up the anther wall. The epidermis consists of rectangular, slightly elongated cells with thin straight anticlinal walls showing papilla [Fig. 12A]. There are no trichomes or stomata on the epidermis. The fibrous layer of anther is formed of 1-3 rows of axially elongated polygonal cells with beaded lignified walls and bar-like thickening and a row of collapsed parenchyma cells with thin walls making up the remaining secretory tapetum [Fig. 11D &E]. The anther was shown to contain intracellular clusters of calcium oxalate [Fig. 12B]. The pollen grains are ellipsoid, yellow in colour, with granular non spiny warty exine and two germinal pores [Fig. 11B].

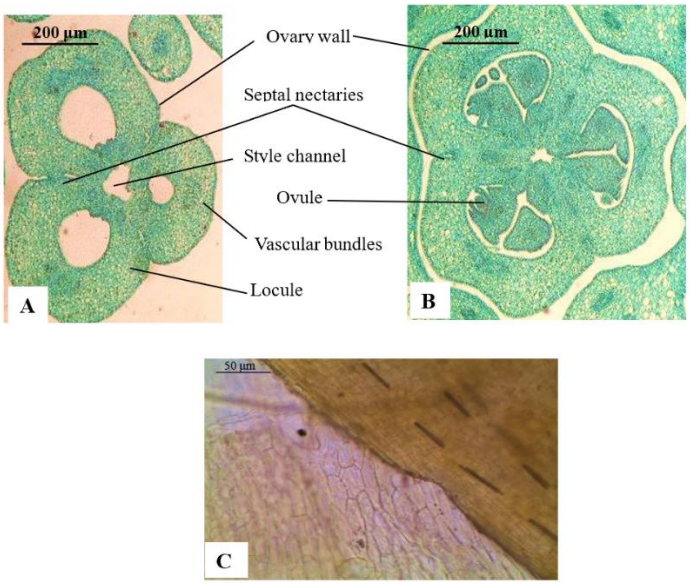

Figure 13. A& B: Detailed T.S. in the ovary (x 40), **C:** Rhaphids of calcium oxalate (x 200).

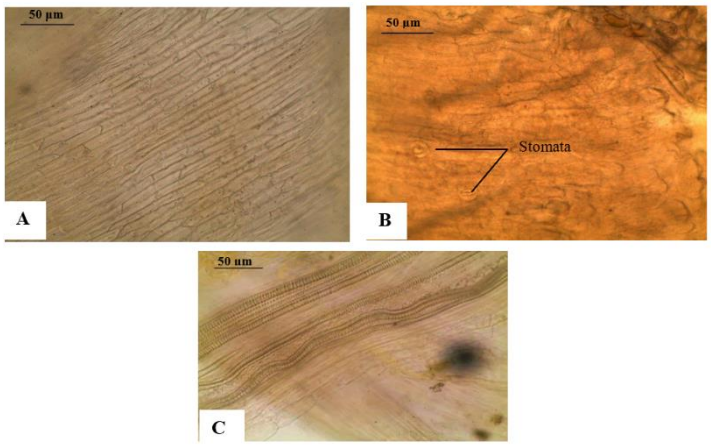

Figure 14. A & B: The style (x 200), **C:** Spiral and scalariform xylem vessels of style (x 200).

The gynoecium

The ovary

A transverse section of the ovary shows three united carpels with three locules with two ovules in each one, showing a glabrous upper and lower epidermis separated by parenchyma cells of the mesophyll [Fig. 13A& B]. Three scattered vascular bundles were observed in the dorsal vein of the ovary. The ovary was observed to contain intracellular raphides [Fig. 13C]. The three gynoecium zones, inner septal nectaries, axial placenta, and the numerous tenuinucellate and anatropic ovules in *Agapanthus* ovary were discussed and reported [10].

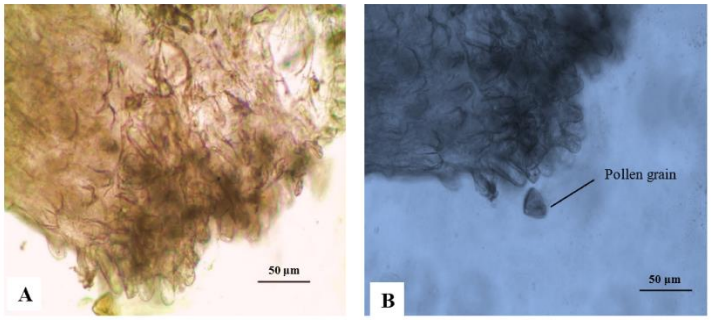

Figure 15. A & B: Papillosed stigma (x 200).

The style

The epidermis consists of polygonal, axially elongated with straight anticlinal walls and covered with a thin smooth cuticle showing anomocytic stomata [Fig. 14A &B]. The xylem vessels in the style were observed to be with spiral and scalariform thickening [Fig. 14C].

The stigma

The Stigma has papillosed polygonal cells with straight anticlinal walls in its epidermis [Fig. 15A &B].

The pedicel

A transverse section of the flower pedicle has an elliptical outline [Fig. 16]. The epidermis consists of thin-walled rectangular cells covered with a thin cuticle, and no trichomes or stomata were observed. The epidermis enclosing wide ground tissue consists of 1-2 rows of collenchyma cells followed by several rows of rounded parenchyma cells. The vascular system consists of 12 to13 closed collateral vascular bundles that are smaller and more densely arranged [8-9] on the outside than they are on the inside [3-4]. Each Vascular bundle is enclosed by thin-walled parenchyma cells of the pericycle similar to that of the pedicel.

The peduncle [the scape]

The T.S of the peduncle appears as subcylindrical in shape [Fig. 17]. The epidermis consists of one row of thin-walled rectangular cells with no trichomes, followed by the cortex that consists of 9-11 rows of large rounded parenchyma cells. Numerous scattered closed vascular bundles are observed in the pericycle and pith regions. Each vascular bundle consists of phloem toward the outside and annular, spiral and scalariform lignified xylem vessels toward the inside with non-lignified parenchyma surrounding the vessels [Fig. 18]. The pith is formed of large thin-walled rounded parenchymatous tissue.

The root

The T.S of the root has a cylinder-shaped appearance showing a layer of cork followed by a wide cortex that encircles the vascular bundles [Fig. 19].

The epidermal tissue

The epidermis consists of 3-4 rows of irregular cells with thin walls covered with a thin smooth cuticle carrying numerous unicellular non branched root hairs. It is followed by one row of hexagonal longitudinally elongated cells with straight walls that constitute the dimorphic hypodermis [exodermis].

The cortex

The cortical region is wide and consists of several layers of thin-walled polygonal to rounded parenchyma cells. The endodermis is present followed by the pericycle. An endodermis with a casparian strip formed the innermost layer of the cortex, it consists of one row of rectangular and axillary elongated cells that are arranged in a ring around the vascular system. The radial and inner tangential walls of the endodermis are thickened [26]. The pericycle may be parenchymatous or indistinguishable. Furthermore, needles of calcium oxalate were observed in the root powder [Fig.20D].

The vascular system

The vascular bundles are radial and arranged in a ring with polyarchy condition [18-20]. The phloem differentiated into sieve tube elements and companion cells, however the xylem is formed of the outer protoxylem and inner metaxylem vessels. The lignified xylem vessels have a scalariform thickening while annular and spiral thickening are not observed in the root [Fig. 20]. The pith consists of thin-walled rounded parenchyma cells. The powdered root is white to pale yellow in colour with a faint characteristic odour and is tasteless. The elements of the powdered roots are shown in Fig. 20.

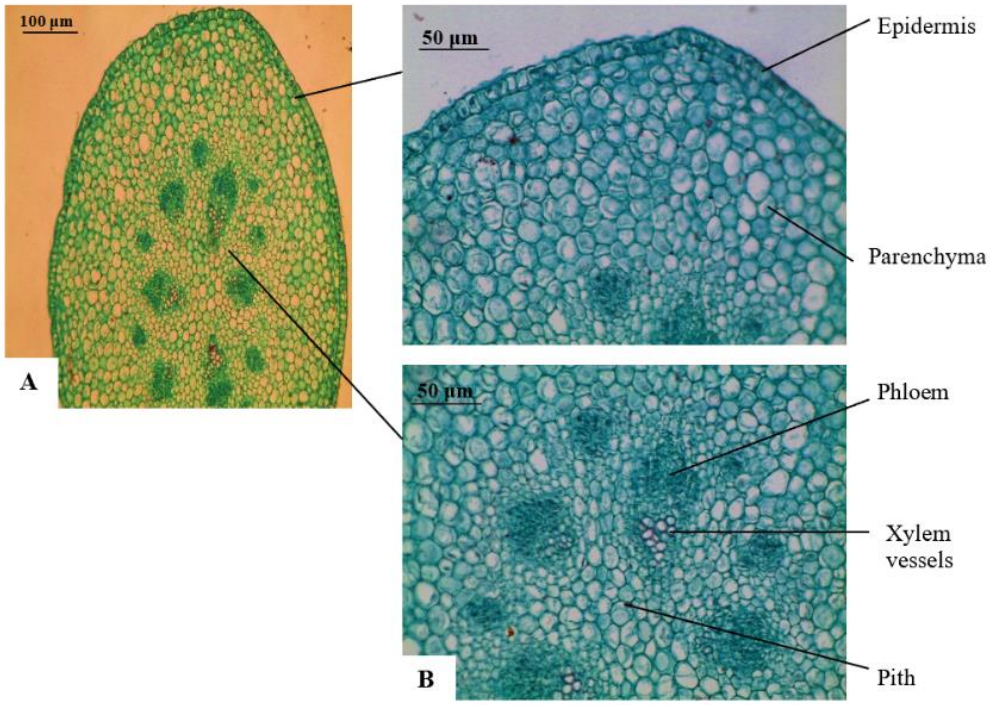

Figure 16. A: T.S. of the pedicle (x 100), **B:** Detailed T.S. of the pedicle (x 200).

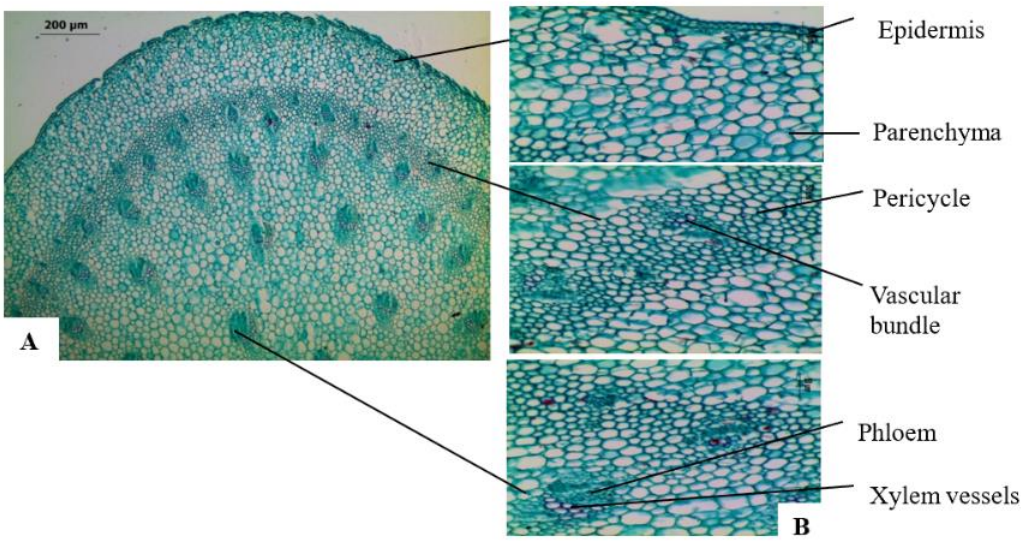

Figure 17. A: T.S. of the peduncle (x 40), **B:** Detailed T.S of the peduncle (x 200).

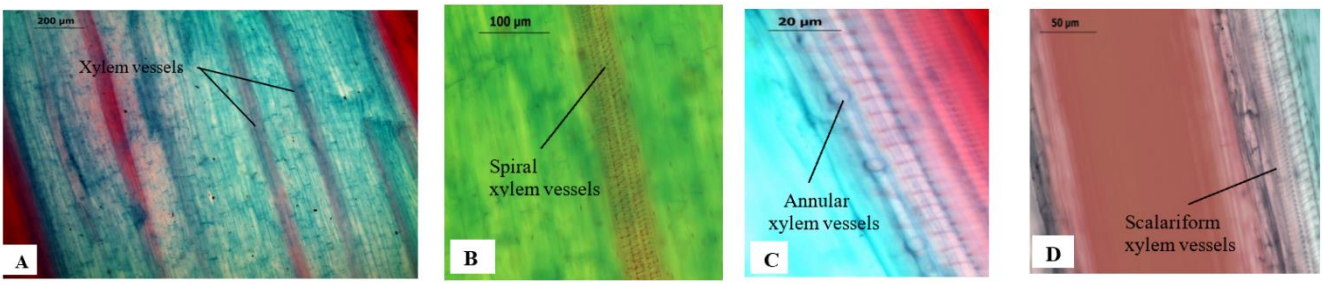

Figure 18. A: L.S of the peduncle (x40), **B:** Spiral xylem (x 100), **C:** Annular xylem (x 400), **D:** Scalariform xylem (x 200).

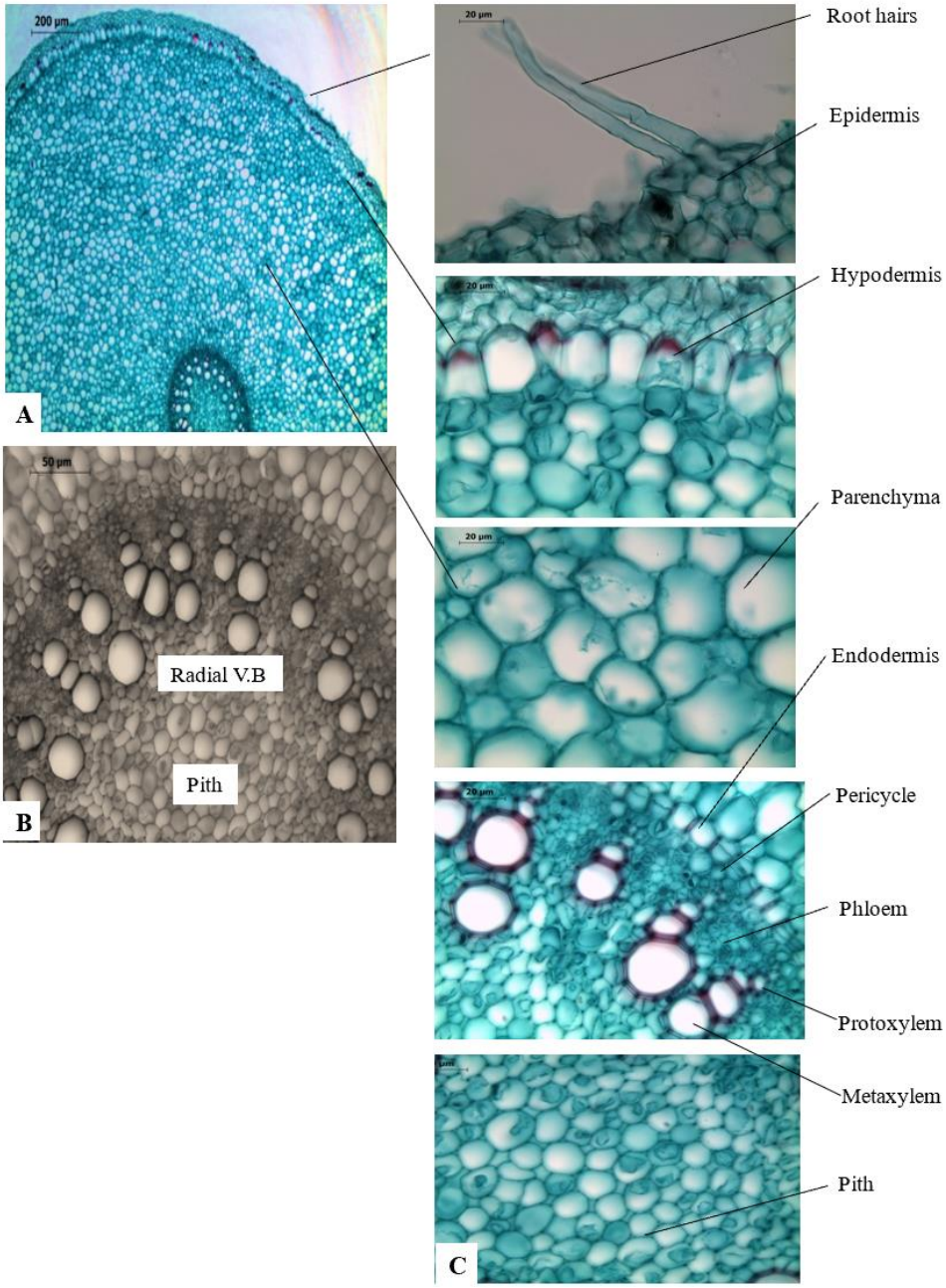

Figure 19. A: T.S. of the root (x 40), **B:** T.S. in the region of vascular system (x 200), **C:** Detailed T.S of the root (x 400).

The rhizome [Fig. 21]

The T.S is sub-cylindrical in shape. The rhizome consists of 6-8 layers of the cork cells surrounding a wide cortex followed by the vascular tissue. There are small and large groups of distinctive sclereids scattered throughout the vascular tissue and cortex, respectively. The vascular bundle is amphivasal with spiral xylem vessels. The powder is yellowish white, odourless, and tasteless.

Cork

It consists of 6-8 rows of tangentially elongated rectangular cells with thin walls as seen in the transverse section, while in the surface view they appear as polygonal, isodiametric to slightly elongated with thick walls and brown content [Fig. 22C].

The secondary cortex

It consists of thin-walled compact rounded parenchyma cells. It is somewhat similar to the cortex of the root but is extensively wider and has cortical cells that are more rounded and smaller. Large heart- shaped groups of sclereids are dispersed through the cortex, which are isodiametric sub-rectangular shaped, axillary elongated, with narrow to wide lumen and thick lignified walls sclereids either in heart-shaped groups or single ones [Fig. 21]. Additionally, calcium oxalate clusters and raphides are observed in the ground tissue, and starch granules are scattered or enclosed in parenchyma cells, particularly nearby to rhizome xylem vessels. The starch granules are rounded, small to medium in size, simple or compound [2-3 granules], with invisible hilum and striations [Fig.22F].

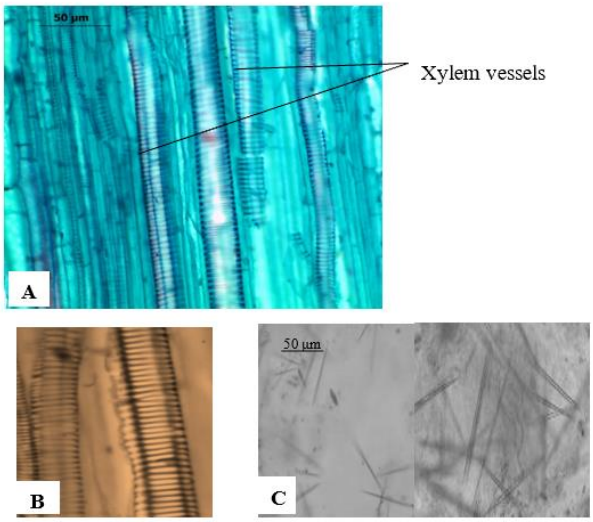

Figure 20. A: L.S. of the root (x 200), **B:** Scalariform xylem vessels (x 400), **C:** Needles of calcium oxalate (x 200).

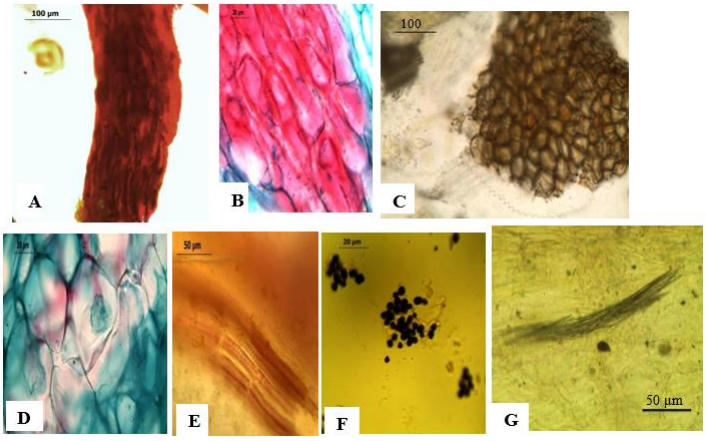

Figure 22. A&B: Sclereids (x 100), (x 400) respectively, **C:** Cork cells (x 100), **D:** Cluster of calcium oxalate (x 400), **E:** Spiral xylem vessels (x 200), **F:** Starch granules (x 400), **G:** Raphides (x 200).

The vascular system

It consists of a numerous randomly distributed concentric amphivasal vascular bundles with various sizes [Fig. 21B]. However, there was no scalariform or annular thickening in the vascular system of the rhizome. Instead, the proto-xylem vessels had spiral thickening [Fig. 22E]. The phloem consists of a small nest and is surrounded by solitary xylem elements. The xylem vessels in the rhizome of genus *Agapanthus* made up the bulk of the vascular bundles and were more conspicuous than the phloem tissues, and a crystal deposits around the xylem vessels were observed [27].

The rhizome powder [Fig. 22]

The powder of the rhizome is yellowish to brown in colour, tasteless, and with a faint characteristic odour. The powder revealed the following items: A fragment of cork cells in the surface view appear as polygonal nearly isodiametric with thick walls and brown content. Numerous sclereids which are isodiametric sub-rectangular shaped, axillary elongated, with narrow to wide lumen and thick lignified walls sclereids either in heart-shaped groups or single ones [Fig.22A &B]. Furthermore, clusters and raphides of calcium oxalate and spiral lignified xylem vessels. And in the rhizome tissue was rich of scattered starch granules which are rounded, small to medium in size, simple or compound [2-3 granules], with invisible hilum and striations.

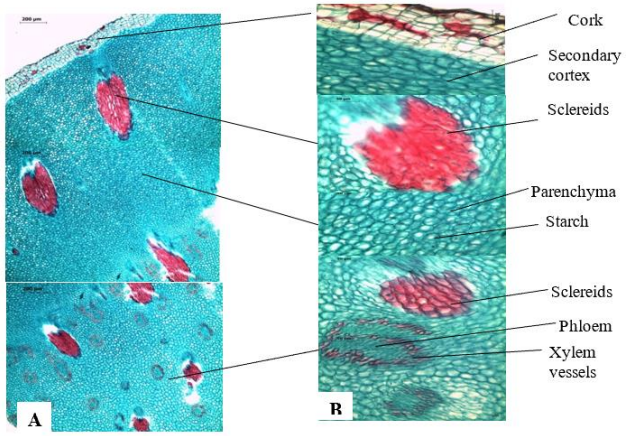

Figure 21. A: T.S of the rhizome (x 40), **B:** Detailed T.S of the rhizome (x 200).

3.3. Phytochemical screening:

The results of phytochemical screening **[Table 2]** revealed the presence of saponins, phenolics, and flavonoids as the major constituents, moderate amounts of deoxy sugar, proteins and/or amino acids, traces of alkaloids, and the absence of coumarins, anthocyanins, and anthraquinones.

4. Conclusion

The current study presents the first investigations of the phytochemical screening, macro and micro-morphological aspects of the various organs of *Agapanthus africanus*. The present research concluded that *A. africanus* lacks the presence of trichomes and is rich in various types of calcium oxalate (especially the leaf). The plant has spiral, scalariform, and pitted lignified xylem vessels. Also, macro and micro morphology of flower, recording ellipsoid non spiny pollen grains, fibrous layer of anther, and papillosed stigma. The findings of the phytochemical screening and the botanical studies of *A. africanus* assessed a potent taxonomical identification, authenticity, and species delimitation of the discussed plant.

Conflicts of interest

The authors declare no conflicts of interest.

Table 1. Micron-scale measurements of various organs of *A. africanus*.

Item	Length	Width	Height	Diameter
Leaf				
Upper epidermis	50-100-150	14-18-23	16-20-24	
Lower epidermis	42-62-83	19-22-25	16-18-20	
Stomata	59-81-104	45-49-54		
Parenchyma of the cortex				24-32-40
Coax clusters				14-18-23
Xylem vessels				8-12-16
Parenchyma of the pith				20-28-36
Coax acicular	58-64-71	2-3-4		
Flower Tepal				
Epidermis	20-27-35	10-12-15	9-11-14	
Stomata	17-21-25	12-18-25		
Parenchyma				9-13-18
Item	**Length**	**Width**	**Height**	**Diameter**
Androecium				
Epidermal tissue of the filament	40-62-85	20-22-25		
Fibrous layer of anther	45-60-75	20-24-35		
Pollen grains	20-21-22	9-10-11		
Coax clusters				3-5-8
Gynaecium				
Epidermis of style	41-68-95	9-11-14		
Epidermis of stigma	21-25-29	17-19-21		
Pedicle				
Epidermis			7-14-21	
Parenchyma of the cortex				6-15-25
Xylem vessels				4-6-8
Parenchyma of the pith				8-12-17
Peduncle				
Epidermis			5-7-10	
Parenchyma				30-40-50
Pericycle				20-30-40
Xylem vessels				10-15-20
Root				
Root hair	112-114-117	7-8-10		
Epidermis			12-19-27	
Hypodermis			22-26-30	
Parenchyma of the cortex				20-26-32
Endodermis			9-10-12	
Pericycle				5-7-10
Xylem vessels				5-17-30
Parenchyma of the pith				12-17-22
Coax needles	71-74-78	5-6-7		
Rhizome				
Cork	30-40-50	25-37-50	25-34-44	
Parenchyma of cortex				19-25-31
Sclereids	56-68-80	20-22-24		
Starch				3-4-6
Coax clusters				16-18-20

Table 2: Results of the preliminary phytochemical screening of the powdered subterranean organs of *A. africanus* L.

Phytoconstituents	Results
1) Microsublimation [28]	-
2) Carbohydrates and/or glycosides [29]	++
3) Flavonoids [30]	++
4) Alkaloids [29]	±
5) Saponins [31]	++
6) Phenolics [29]	++
7) Cardiac glycosides (deoxy sugar)[29]	+
8) Tannins [29]	++
9) Sterols and/or triterpenes [32]	++
10) Anthraquinones [29]	-
11) Proteins/amino acids [29]	+
12) Anthocyanins [29]	-
13) Coumarins [29]	-

(++) Major (+) Moderate (±) Minor (-) Absent

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