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ORIGINAL ARTICLE

Botanical and genetic characteristics of *Farsetia aegyptia* Turra growing in Egypt

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KEYWORDS

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Abstract *Farsetia aegyptia* Turra is a perennial woody desert shrub native to Egypt. It is used by native Bedouins as an anti-diabetic and antispasmodic. Study of the botanical features was carried out for the root, young and old stems, leaf, fruit and seed of the plant. *F. aegyptia* Turra was characterized by the presence of myrosin cells and non-glandular branched unicellular two-armed hairs in the stem, leaves and fruit, while the root showed sclereids with a wide or narrow lumen and lignified pitted walls. Furthermore, the DNA of the plant was extracted from leaf samples and analysed using ten random decamer primers. A total of 58 random amplified polymorphic DNA (RAPD) markers were identified. Both the botanical study and the DNA fingerprint helped in the identification of the plant.

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1. Introduction

Family Cruciferae is one of the largest families in the plant kingdom. It is known for its richness in medicinal plants. It consists of about 365 genera and 3250 species with a wide distribution especially in the Mediterranean region to central Asia, and North West America.[1] Members of this family are mostly herbs, rarely shrubs or subshrubs.

Farsetia is one of the cruciferous genera.[1,2] It consists of 25 species, distributed from North Africa to North West India.[2]

Farsetia aegyptia Turra is used by native Bedouins as an anti-diabetic and antispasmodic. Moreover, it is used for the relief of rheumatic pains and taken internally as a cooling medicine after pounding.[3]

The leaves and the stem of *F. aegyptia* Turra are prepared in Morocco as a decoction for toothache, gingivitis and sore eyes.[4]

Members of family Cruciferae are characterized by the presence of alternate, simple, exstipulate leaves which are often varying from entire to palmate or pinnatifid. The fruit is a type of capsule, siliqua (at least 3 times as long as its width) or a silicula (less than 3 times in length as in width), rarely indehiscent and often flattened. The septum of the fruit remains on the plant when the seeds fall. The seeds are arranged in 1 or 2 rows, winged or not, with the embryo folded, accumbent or incumbent, conduplicate or very rarely straight.[1,2,5] The cruciferous plants possess characteristic secretory cells whose essential constituent is myrosin, consequently termed myrosin cells. Hairs are usually unicellular, sometimes simple unbranched or Y-shaped.[6,7]

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A literature survey indicated that no data are available on the anatomical features of *F. aegyptia* Turra. The present work includes a study of the morphological and anatomical features, as well as, the DNA fingerprint of the plant to facilitate the identification of the plant both botanically and genetically.

2. Experimental

2.1. Plant material

Samples of *F. aegyptia* Turra used in this study were collected in May in the fruiting stage during the years 2008–2010 from El-Katameya, El-Ain El-Soukhna road, Egypt and were identified by Dr. Mohamed El-Gebali, senior botanist, National Research Centre.

2.2. Botanical study

Specimens for morphological studies were dried according to standard herbarium techniques and voucher samples were kept in the Department of Pharmacognosy, Faculty of Pharmacy, Cairo University. Photographs were taken using a Samsung digital camera.

Anatomical investigations were performed on cross-sections of the root, young and old stems, leaves, fruits and seeds which were preserved in 70% alcohol containing 5% glycerol and on air-dried finely powdered samples. The photographs were taken using a Leica DFC500 digital camera.

2.3. DNA fingerprint

Entire fresh leaves of the plant under investigation were freeze-dried and ground to fine powder under liquid nitrogen prior to DNA extraction.

2.3.1. DNA extraction

DNA was extracted from 10 g of leaf tissue in 1.5 ml microcentrifuge tubes using the DNA extraction method described by Williams et al.[8]

2.3.2. Oligonucleotide primers

A total of 10 random decamer oligonucleotide primers (Operon Technologies Inc.) were used to amplify *Farsetia* genomic DNA. They have the following sequence: A-11: CAATC GCCGT, B-06: TGCTCTGCCC, B-08: GTCCACACGG, E-20: AACGGTGACC, E-04: GTGACATGCC, F-06: GGG AATTCGG, G-06: GTGCCTAACC, G-18: GGCTCATGT G, O-04: AAGTCCGCTC and Z-13: GACTAAGCCC.

2.3.3. Polymerase chain reaction (PCR)

PCR amplification was conducted using 25 μl of reaction mixture containing 1% Triton 10-X reaction buffer (100 mM Tris–HCl (pH = 8.3), 500 mM KCl, 0.01% (w/v) gelatin), 2.0 μl $MgCl_2$ (25 mM), 2.5 μl of each dNTP (2 mM), 3 μl primer, 0.3 μl of Taq polymerase (Promega), and 2.5 μl of genomic DNA, completed to volume with distilled water. The reaction mixture was overlaid with 2 drops of mineral oil. The amplification reaction was carried out in a Thermocycler Perkin Elmer Cetus 480 (Warrington, UK). The thermocycler was programmed for 1 cycle of 5 min initial strand separation at 94 °C and for 40 cycles each 1 min at 94 °C for denaturation, 1 min primer annealing at 36 °C, a 7 min primer elongation at 72 °C, followed by 1 cycle of final primer extension at 72 °C for 10 min.

2.3.4. Gel electrophoresis and staining

PCR products were separated in 1.5% agarose gel by electrophoresis in TE buffer (10 mM Tris-HC1, 1.0 mM EDTA, pH = 8.0) with a constant power of 95 volts for about 3 h. The products were stained with 0.5 μg/ml ethidium bromide and then visualized and photographed under UV light using Polaroid camera type 57 (ASA 3000).

3. Results

3.1. Botanical study

3.1.1. Macromorphology

F. aegyptia Turra (Figure 1A and B) is a perennial woody greyish green to greyish brown desert shrub native to Egypt. It reaches 30–60 cm in height.

The plant is tough and wholly covered with appressed tiny whitish hairs. The stem is erect and densely branched. The flowering period starts in January and ends at the beginning of March while the fruiting period ends in May.

3.1.1.1. The root. The root is bright yellow to yellowish brown in colour. It shows lateral branching (Figure 1C) where the main root is very tough and harder than the smaller branches.

The surface is usually rough showing numerous wrinkles and longitudinal fissures. The cork is easily separated from the inner tissues exposing a yellow interior (Figure 1D). The fracture of the root is fibrous on the inner part and smooth on the outer part. The main root measures 1–4 cm in diameter, while the lateral branch measures 0.3–1 cm in diameter and extends 10–90 cm laterally below the soil. The root possesses a characteristic odour and a pungent taste.

3.1.1.2. The young stem. The young stem is erect, herbaceous and cylindrical (Figure 2A). It is greyish green sometimes with violet tinge, showing a solid bright yellow interior. It measures 0.2–0.3 cm in diameter. The surface is rough and covered with appressed whitish hairs. The lateral buds are green, 0.1–0.2 cm in length and covered with tiny whitish hairs.

The young stem has a short, splintery fracture. It has a characteristic odour with slightly pungent taste.

3.1.1.3. The old stem. The old stem is yellowish brown in color, hard and rough with sympodial branching (Figure 2B). It measures 0.3–0.6 cm in diameter. It shows a wrinkled surface with longitudinal fissures and transverse cracks. It breaks with a fibrous fracture. The cork may exfoliate exposing a buff internal surface. The old stem is odourless and has a slightly pungent taste.

3.1.1.4. The leaf. Leaves are alternate, sessile and exstipulate. The lamina is simple, linear oblong in shape with an acute sometimes obtuse or emarginated apex (Figure 2C).

The upper and lower surfaces are dark green to greyish green, sometimes with a reddish tinge on the whole surface or near the apex only (Figure 2D and E). The surface is rough

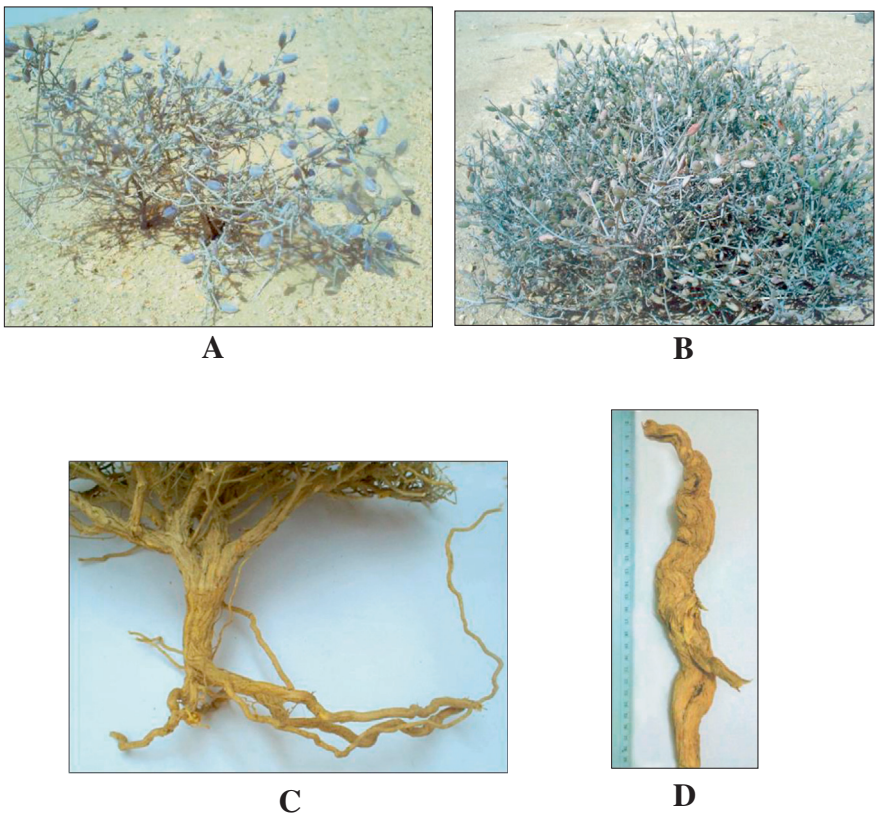

Figure 1 Photographs of the young shrub, the old shrub (in the fruiting period) and the root of *Farsetia aegyptia* Turra. (A) The young shrub (X 0.13). (B) The old shrub (X 0.13). (C) The mode of branching of the root (X 0.07). (D) Part of the main root (X 0.19).

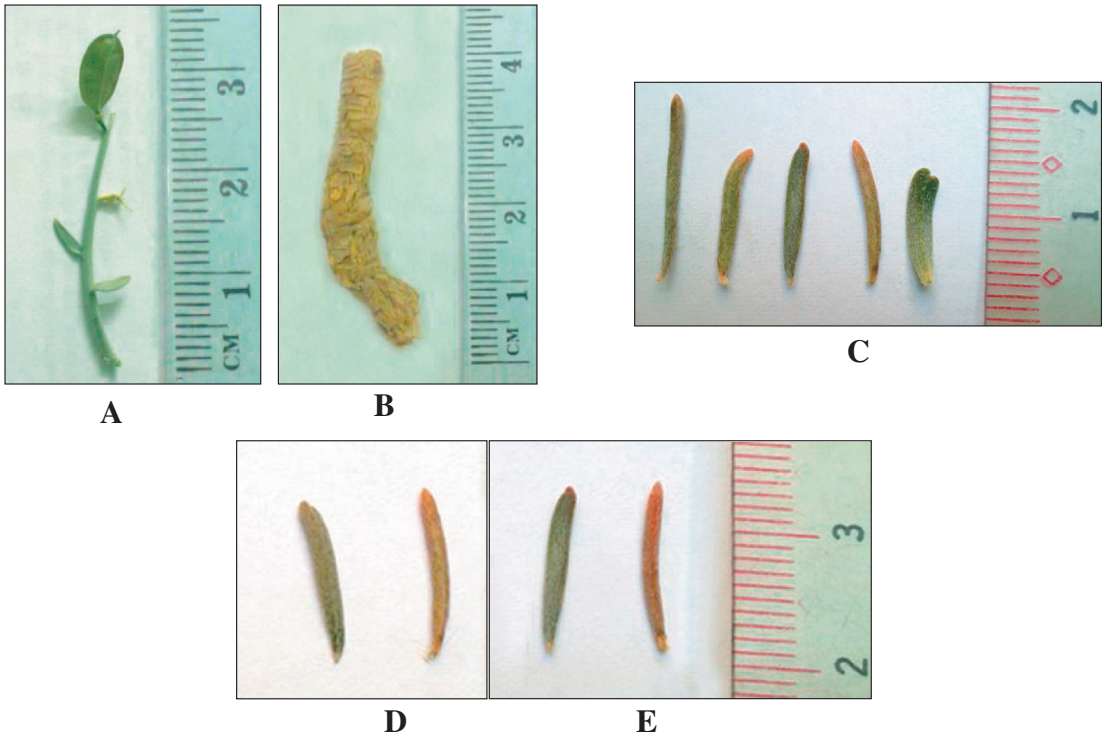

Figure 2 Photographs of the young stem, the old stem and the leaves of *Farsetia aegyptia* Turra. (A) The young stem showing a fruit and alternate leaves (X 1.43). (B) The old stem (X 1.12). (C) Different shapes of the leaves (X 1.5). (D) The upper surface of the leaf (X 2). (E) The lower surface of the leaf (X 2).

and covered with longitudinally appressed fine whitish hairs parallel to the midrib leading to indistinct venation. The midrib is prominent on the lower surface.

The leaf has a slightly fleshy texture. It measures 0.3–2 cm in length and from 0.1–0.3 cm in width. The leaf has a characteristic odour and a slightly pungent taste.

3.1.1.5. The fruit. The fruit is true, simple, dry and dehiscent siliqua which opens with 2 flat or convex valves, ovate-oblong to elliptical in shape, more or less obtuse with a distinct style, attached to a very short pedicel that measures 1–2 mm in length (Figure 3A). The surface of the fruit is rough and covered with closely appressed fine whitish hairs.

The pericarp is pale green to greyish green, sometimes with a violet tinge (Figure 3A). It is thin, indistinguishable having epicarp, mesocarp and endocarp.

The fruit is derived from a superior bicarpellary bilocular ovary with a very thin membranous finely veined septum between the two locules. The septum may remain attached to the fruit pedicel after the seeds and pericarp fall off (Figure 3B). The fruit contains about 14–22 seeds attached to a parietal placentation where the seeds are attached to the junctions between the 2 valves of the fruit (Figure 3C). It measures 0.9–2 cm in length, 0.4–0.7 cm in width and 0.1–0.2 cm in thickness. The fruit possesses a faint characteristic odour and slightly pungent taste.

3.1.1.6. The seed. The seed is circular in shape, flattened and broadly winged with a transparent membranous wing (Figure 3D). It measures 0.2–0.4 cm excluding the wing which reaches 0.1–0.2 cm along the circumference of the seed.

The testa is thin, brittle, orange brown to dark reddish brown in colour, glabrous with a fine reticulated surface. The raphe (Figure 3D) is distinct as a small groove near one edge of the seed separating the position of radicle from that of the cotyledons (Figure 3E). The seed is albuminous, derived from anatropous ovule, with an accumbent embryo (Figure 3F) and two thin pale yellow cotyledons. The seed possesses a characteristic pungent odour and a mucilagenous pungent taste.

3.1.2. Micromorphology

3.1.2.1. The root. A transverse section (Figure 4A and B) in the root is more or less circular in outline. It is formed of an outer cork, followed by the secondary cortex which is formed of parenchyma cells. The pericycle is formed of groups of sclereids. The endodermis is indistinct. The vascular system is relatively wide forming a ring.

3.1.2.1.1. The cork. The cork cells (Figure 4B and C) are tangentially elongated tabular cells with lignified walls. They are radially arranged in several rows that may reach 50 rows where some rows are collapsed.

3.1.2.1.2. The cortex. It consists of 6–9 rows of oval thin-walled parenchyma cells (Figure 4B and C) containing scattered starch granules. They are simple or compound (2–3), rounded, with neither visible hila nor striations. The endodermis is indistinct.

3.1.2.1.3. The pericycle. It is formed of groups of sclereids (Figure 4B and C). The sclereids are polygonal isodiametric or elongated with thick pitted lignified walls showing a wide

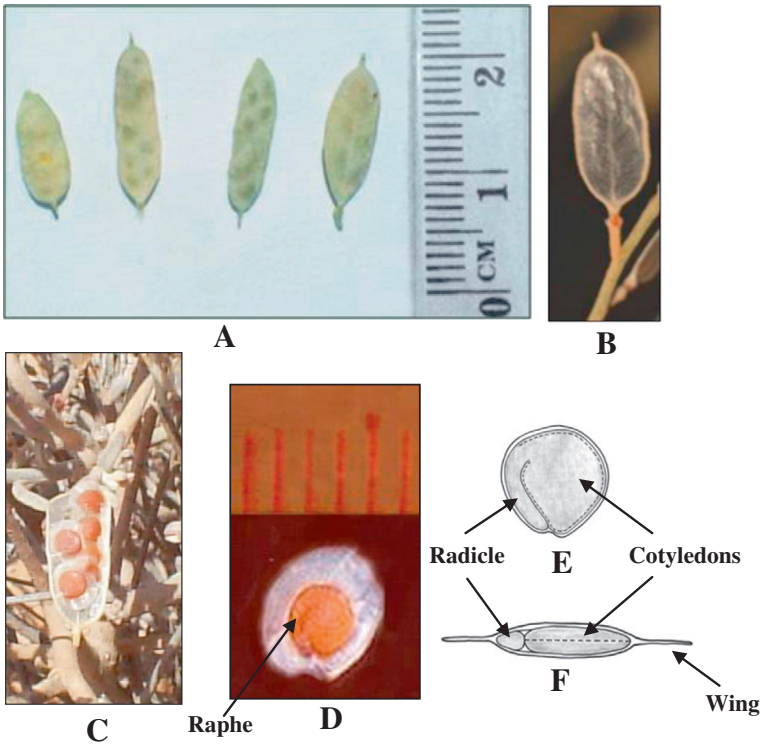

Figure 3 Photographs of the fruit and the seed of *Farsetia aegyptia* Turra. (A) Entire ripe fruits (X 1.7). (B) The membranous veined septum left after falling of the seeds (X 1.25). (C) Opened fruit showing the seeds attached to the membranous septum (X 1.53). (D) Entire mature seed showing the raphe (X 4.6). (E) Sketch of the longitudinal cut in the seed. (F) Sketch of the transverse cut in the seed.

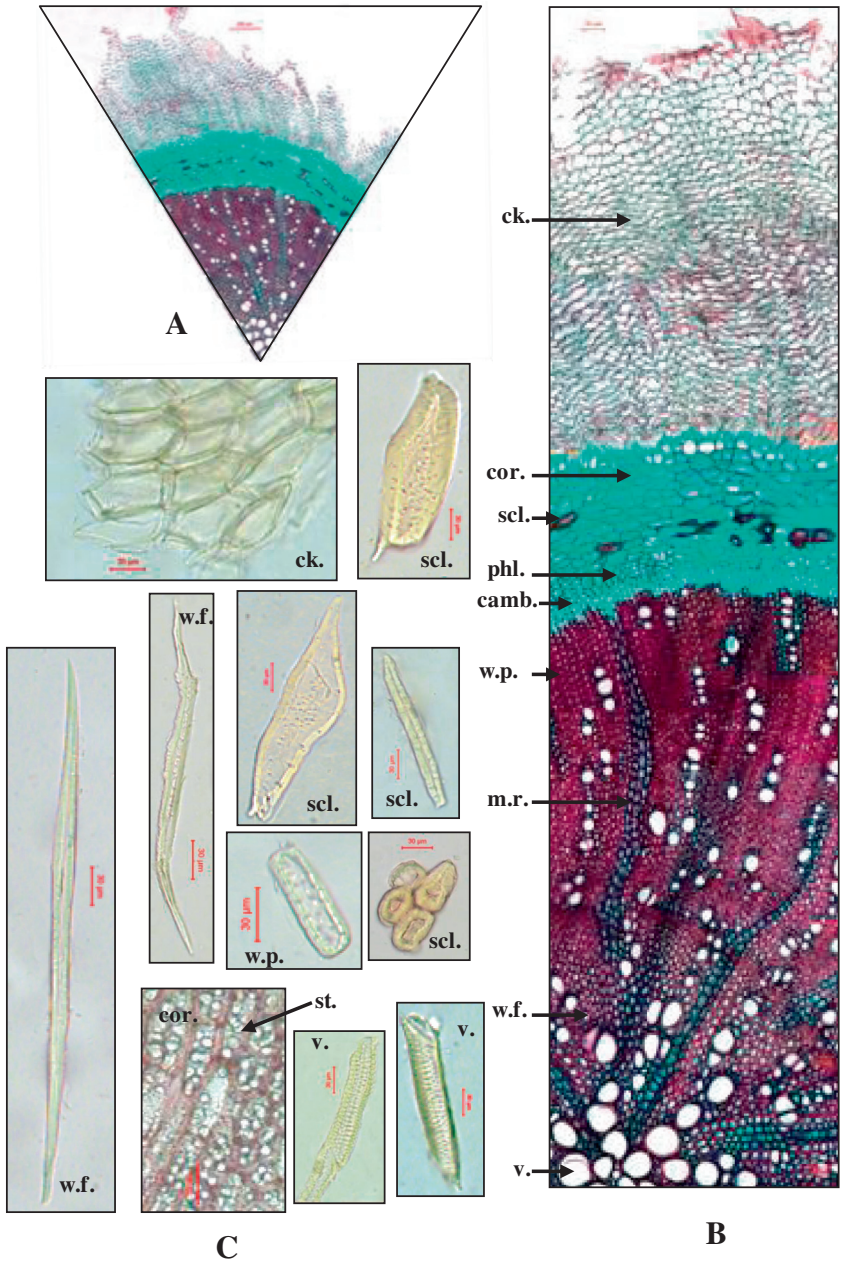

Figure 4 Micromorphology of the root of *Farsetia aegyptia* Turra. (A) Low power view of the T.S. in the root (X 25). (B) Detailed sector of the root (X 80). (C) Powdered root. camb., cambium; ck., cork cells (X 200); cor., cortex (X 200); m.r., medullary rays; ph., phloem; scl., sclereids (X 200); st., starch granules; v., xylem vessel (X 166.6); w.f., wood fibre (X 233.3); w.p., wood parenchyma (X 300).

or narrow lumen. They are interrupted with thin-walled parenchyma cells containing starch granules.

3.1.2.1.4. The vascular tissue. The vascular tissue (Figure 4B and C) is very wide and traversed by uni-, bi- or triseriate medullary rays. The phloem is formed mainly of thin-walled phloem parenchyma, sieve tubes, and companion cells.

The cambium is formed of 3–5 rows of tangentially elongated thin-walled cellulosic cambiform cells. The xylem is formed of lignified radially arranged elements. The vessels are mostly pitted. Wood fibres are fusiform, with straight or undulating lignified walls, narrow lumina and acute apices. Wood parenchyma consists of rectangular elongated cells with pitted lignified walls.

The outer region of xylem representing the secondary xylem contains less vessels and more wood fibres, while the inner region forming the primary xylem shows wider vessels. The medullary rays are wavy uni-, bi- or triseriate and are formed of rectangular polygonal cells with lignified walls and containing starch granules.

3.1.2.1.5. The powdered root. The powder (Figure 4C) is yellow in colour having a characteristic odour and a pungent taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of cork cells which are polygonal cells with lignified walls.

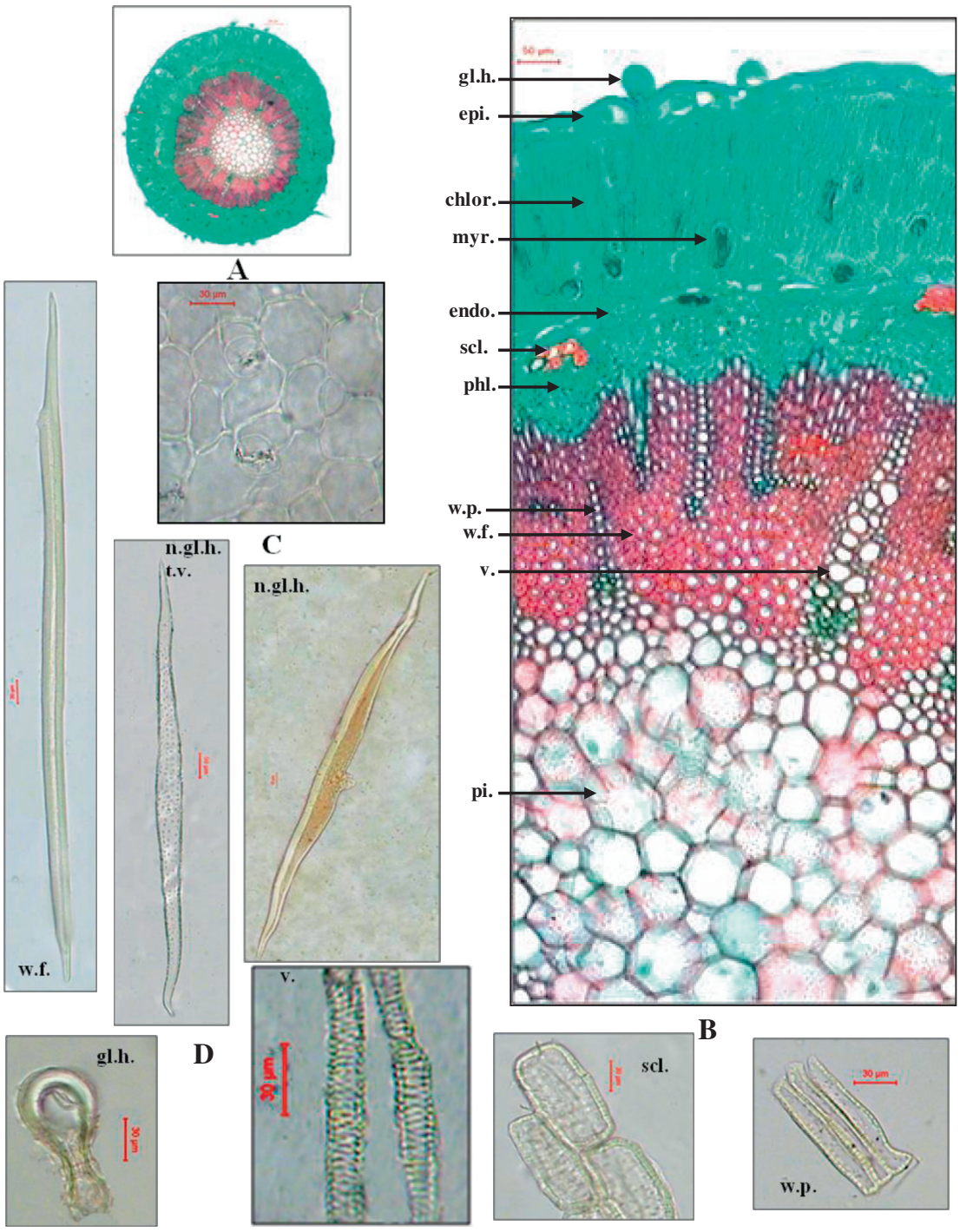

Figure 5 Micromorphology of the young stem of *Farsetia aegyptia* Turra. (A) Low power view of the transverse section (T.S.) in the young stem (X 20). (B) High power view of the T.S. in young stem (X 140). (C) Surface preparation of the young stem (X 233.3). (D) Powdered young stem. chlor., chlorenchyma; endo., endodermis; epi, epidermis; gl.h., glandular hair (X 233.3); myr., myrosin cells; n.gl.h., non-glandular hair (X 40); n.gl.h.t.v., non-glandular hair top view (X 80); phl., phloem; pi., pith; scl., sclereids (X 166.6); v., xylem vessel (X 400); w.f., wood fibre (X 133.3); w.p., wood parenchyma (X 233.3).

2. Fragments of sclereids with a wide or narrow lumen and pitted lignified walls.
3. Fragments of lignified wood fibres with straight or undulating lignified walls, narrow lumina, and acute apices.
4. Fragments of lignified xylem vessels which are mostly pitted.
5. Fragments of wood parenchyma with pitted lignified walls.
6. Fragments of parenchyma cells of cortex containing starch granules.

3.1.2.2. The young stem. A transverse section in the young stem (Figure 5A) is circular in outline. It is formed of an epidermis, followed by the cortex which is formed of chlorenchymatous

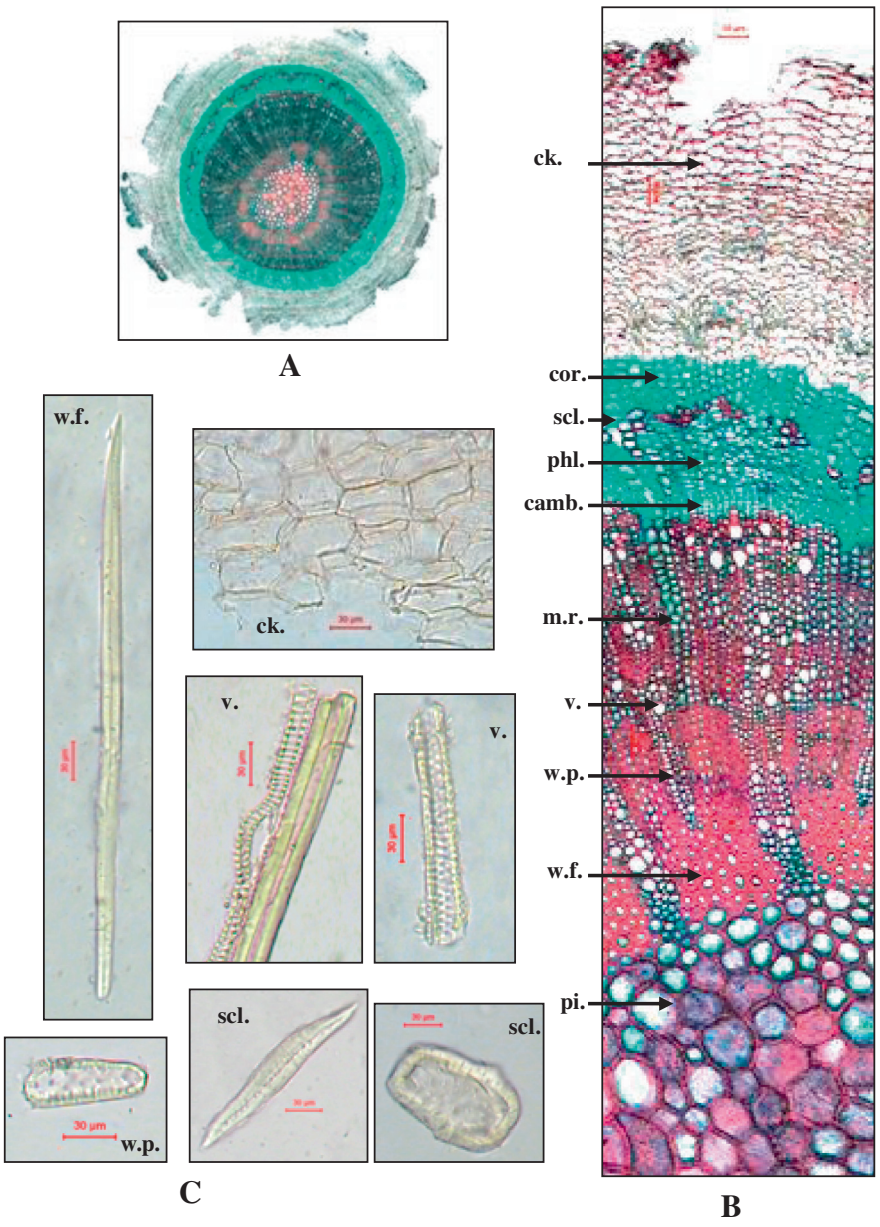

Figure 6 Micromorphology of the old stem of *Farsetia aegyptia* Turra. (A) Low power view of the T.S. in the old stem (X 15). (B) High power view of the T.S. in the old stem (X 100). (C) Powdered old stem. camb., cambium; ck., cork cells (X 233.3); cor., cortex; m.r., medullary rays; phl., phloem; pi., pith; scl., sclereids (X 200); v., xylem vessel (X 233.3); w.f., wood fibre (X 233.3); w.p., wood parenchyma (X 333.3).

tissue. The pericycle is parenchymatous showing lignified sclereids. The vascular tissue is relatively wide forming a ring. The pith is narrow showing lignified pitted parenchyma.

3.1.2.2.1. The epidermis. The epidermis (Figure 5B–D) is composed of one row of polygonal cells, having straight anticlinal walls and covered with thick smooth cuticle. The epidermal cells contain mucilage (stained red with ruthenium red in T.S.) and show anisocytic stomata. Hairs are abundant, non-glandular branched unicellular calcified two-armed medifixed and covered with warty or smooth cuticle. Few glandular hairs are present, they have unicellular stalk and unicellular head, covered with smooth cuticle.

3.1.2.2.2. The cortex. The cortex (Figure 5B) is formed of 3–4 rows of elongated chlorenchymatous cells followed by 1–2 rows of rounded parenchyma cells containing few starch granules (stained blue with iodine solution in T.S.). The cortical tissue shows frequent idioblasts of myrosin cells showing brownish to yellowish brown content (gives rose red with Millon's reagent in T.S.). The endodermis is distinct showing tabular flattened cells.

3.1.2.2.3. The pericycle. The pericycle (Figure 5B and D) is formed of oval parenchymatous cells with scattered lignified sclereids. The sclereids are polygonal with thin or thick lignified pitted walls and narrow to wide lumina.

3.1.2.2.4. The vascular tissue. It consists of a complete ring of collateral vascular bundle (Figure 5B).

The phloem consists of thin-walled phloem parenchyma, sieve tubes and companion cells.

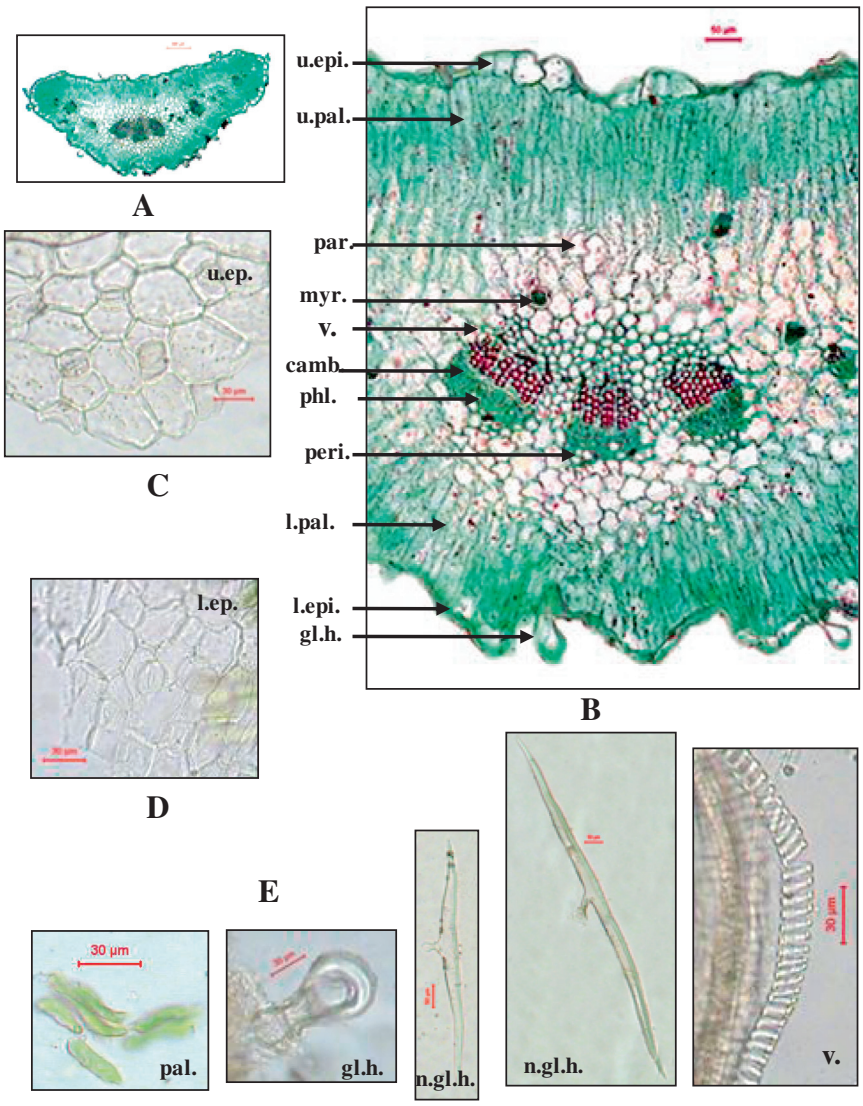

Figure 7 Micromorphology of the leaf of *Farsetia aegyptia* Turra. (A) Low power view of the T.S. in the leaf. (X 25). (B) High power view of the T.S. in the midrib (X 140). (C) Surface preparation in the upper epidermis (X 233.3). (D) Surface preparation in the lower epidermis (X 233.3). (E) Powdered leaf. camb., cambium; gl.h., glandular hair (X 233.3); l.ep., lower epidermis; l.pal., lower palisade; n.gl.h., non-glandular hair (X 60); myr, myrosin cells; pal., palisade (X 366.6); par, parenchyma cells; peri, pericycle; phl., phloem; u.ep., upper epidermis; u.pal., upper palisade; v., xylem vessel (X 333.3).

The xylem is formed of lignified radially arranged elements. The vessels show spiral and pitted thickenings. Wood fibres are present in groups; they are fusiform, with narrow lumina and acute apices. Wood parenchyma consists of rectangular elongated cells with pitted lignified walls.

3.1.2.2.5. The pith. The pith (Figure 5B) is formed of rounded parenchyma cells, with pitted slightly lignified walls.

3.1.2.2.6. The powder of the young stem. The powder (Figure 5D) is greenish yellow in colour having a characteristic odour and a slightly pungent taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of polygonal slightly elongated epidermal cells having straight anticlinal walls, covered with thick smooth cuticle and showing anisocytic stomata.
2. Numerous scattered non-glandular branched unicellular two-armed hairs, as well as, glandular hairs with unicellular head and unicellular stalk.
3. Fragments of sclereids with a wide or narrow lumen.
4. Fragments of lignified wood fibres with straight walls, narrow lumina, and acute tapering apices.
5. Fragments of lignified xylem vessels with spiral and pitted thickenings.
6. Fragments of wood parenchyma cells having pitted and lignified walls.

3.1.2.3. The old stem. The structure of the old stem (Figure 6A and B) is more or less similar to that of the young stem, with the following differences:

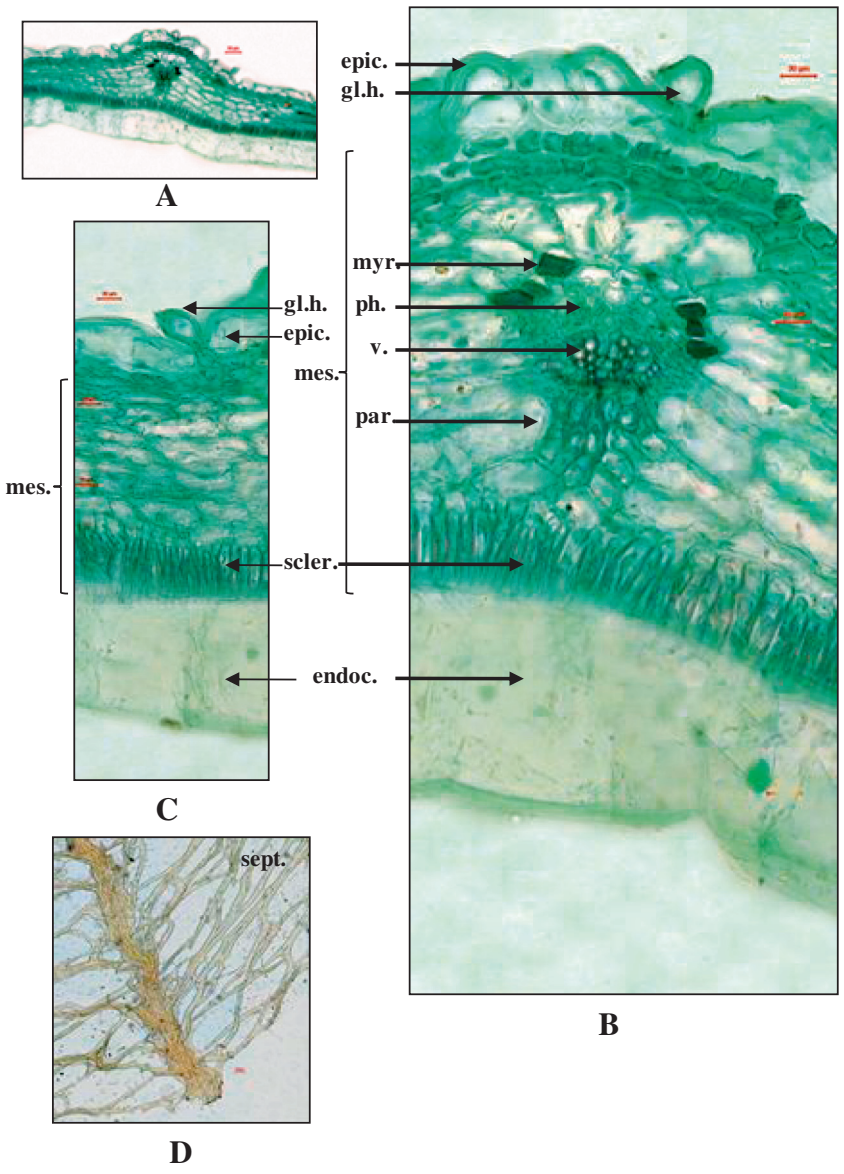

Figure 8 Micromorphology of the fruit of *Farsetia aegyptia* Turra. (A) Low power view of the T.S. in the fruit (X 60). (B) High power view of the T.S. in the central part of the fruit valve (X 200). (C) High power view of the peripheral part of the fruit valve (X 133.3). (D) Low power view of the septum (X 40). endoc., endocarp; epic., epicarp; gl.hr., glandular hair; mes., mesocarp; myr., myrosin cells; par., parenchyma cells; phl., phloem; sept., septum; scler, sclerenchyma cells; v., xylem vessel.

1. Absence of epidermal cells and presence of cork cells (Figure 6) which are radially arranged in several rows that may reach 35 or 40 rows. They are polygonal, tangentially elongated cells with slightly lignified walls. The cork is followed by a narrow phelloderm.
2. The secondary cortex (phelloderm) is narrower and formed of 4 to 6 rows of rounded parenchyma cells. Idioblasts of myrosin are absent in the cortex.
3. The endodermis is indistinct.
4. The vascular tissue is wider and the pith is narrower with pitted more lignified parenchyma cells containing starch granules. The medullary rays are wavy uni-, bi- or triseriate and are formed of rectangular polygonal cells with lignified walls.
5. The cambium is formed of 5–10 rows of tangentially elongated thin-walled cellulosic cambiform cells.
6. Starch granules are present in the medullary rays and pith. They are not abundant or nearly absent in the cortex. The starch granules are simple or compound (2–3), rounded with neither visible hila nor striations.

3.1.2.3.1. The powder of old stem. The powder (Figure 6C) is brownish yellow in colour, odourless and has a slightly pungent taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of polygonal, slightly lignified cork cells.
2. Fragments of sclereids with a wide or narrow lumen.

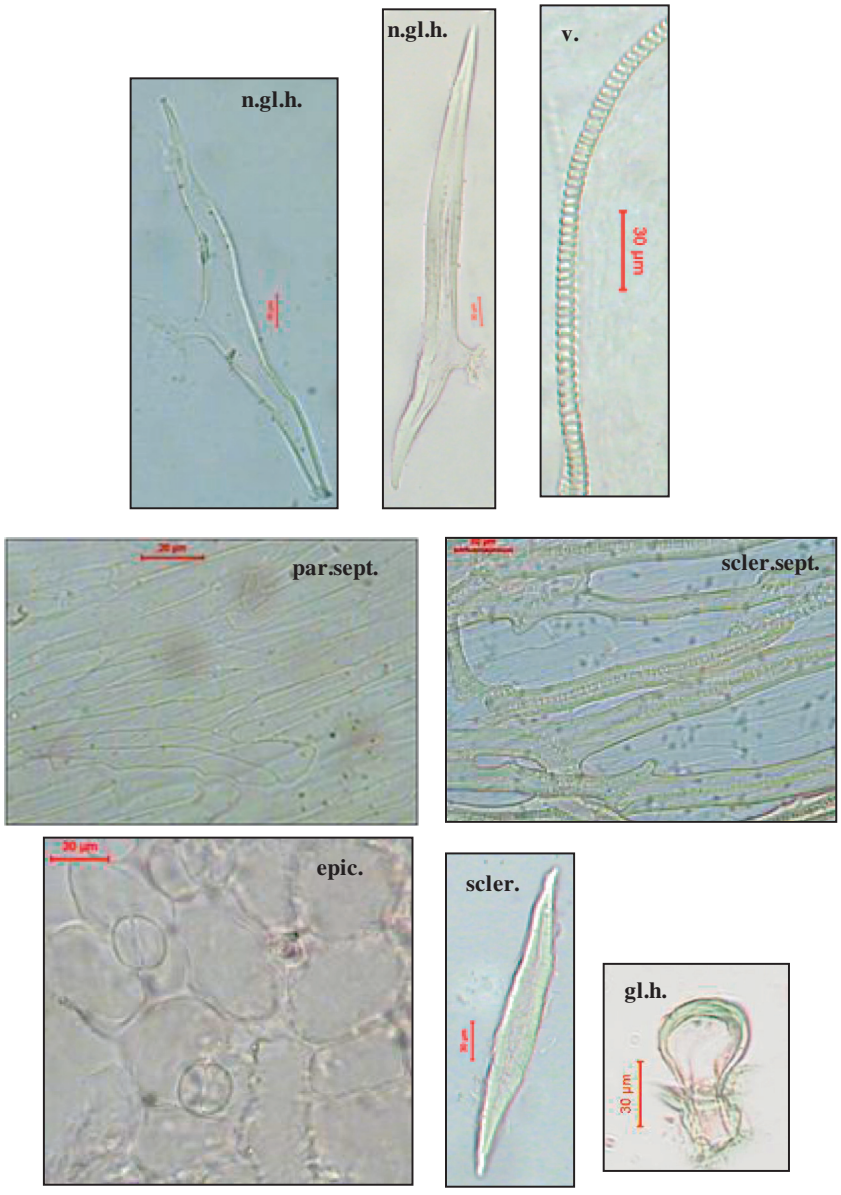

Figure 9 Micromorphology of the powdered fruit of *Farsetia aegyptia* Turra. epic., epicarp (X 300); gl.hr, glandular hair (X 333.3); n.gl.hr, non-glandular hair (X 166.6); par. sept., parenchyma cells of septum (X 450); scler, sclerenchyma cells (X 200); scler.sept., sclerenchyma cells of septum (X 450); v, xylem vessel (X 433.3).

3. Fragments of lignified wood fibres with straight walls, narrow lumina, and having acute tapering apices.
4. Fragments of lignified xylem vessels with spiral and pitted thickenings.
5. Fragments of wood parenchyma cells having pitted and lignified walls.

3.1.2.4. The leaf. 3.1.2.4.1. The leaf lamina. A transverse section in the leaf (Figure 7A and B) shows upper and lower epidermis, enclosing an isobilateral mesophyll. The vascular bundles are collateral with parenchymatous pericycle.

3.1.2.4.2. The epidermis. The upper and lower epidermis (Figure 7B–D) are nearly similar. They show polygonal isodiametric or slightly axially elongated cells with straight anticlinal walls in the upper epidermis and slightly wavy anticlinal walls in the lower epidermis. They are covered with thick smooth cuticle and show anisocytic stomata. The upper and lower epidermal cells contain mucilage.

Hairs (Figure 7E) are abundant covering both surfaces. They are similar to the hairs present on the surface of the young stem.

3.1.2.4.3. The mesophyll. The palisade tissue (Figure 7B) consists of 2–3 rows of columnar closely packed cells, having straight anticlinal walls and containing green plastids. The palisade cells are extended continuously on both the upper and lower surfaces, being shorter on the lower surface. The spongy tissue is narrow formed of irregularly shaped parenchyma

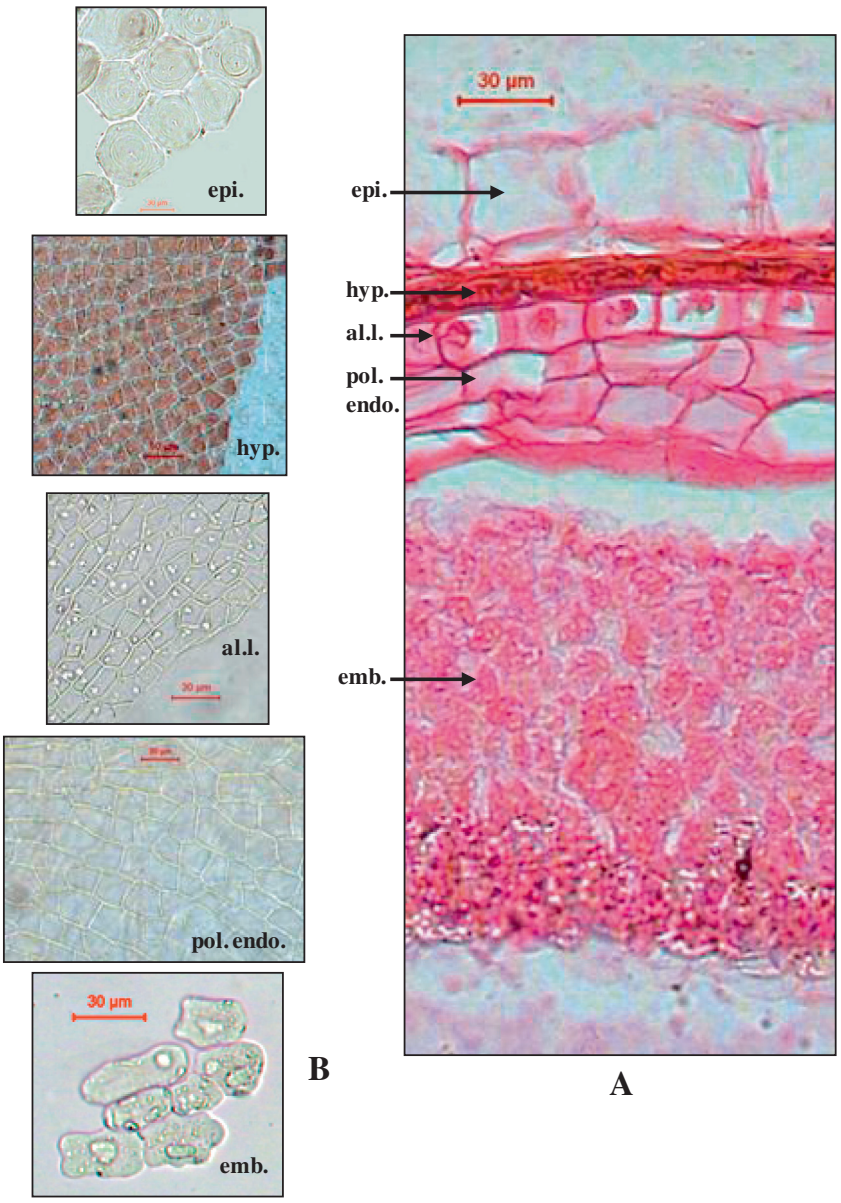

Figure 10 Micromorphology of the seed of *Farsetia aegyptia* Turra. (A) High power view of the T.S. in the seed (X 533.3). (B) Powdered seed. al.l., aleurone layer (X 300); emb., embryo (X 400); epi., epidermis (X 200); hyp., hypodermis (X 140); pol.endo., polygonal cells of endosperm (X 200).

cells. Small vascular bundles are embedded within the spongy tissue.

3.1.2.4.4. The midrib. The cortical tissue (Figure 7B) of the midrib consists of 4–5 rows of irregularly shaped thin-walled parenchyma cells beneath the upper palisade. Small thick-walled parenchyma cells are present above the vascular bundle. The parenchyma cells contain idioblasts of myrosin cells showing yellowish content.

3.1.2.4.5. The pericycle. It is composed of slightly thick-walled rounded parenchyma cells (Figure 7B).

3.1.2.4.6. The vascular tissue. The vascular tissue (Figure 7B and E) is composed of a collateral vascular bundle dissected longitudinally into three strands. Each vascular strand is oval in shape.

The xylem vessels show spiral and annular lignified thickenings. The cambium is formed of 2 rows of radially arranged small thin-walled cellulosic cambiform cells. The phloem tissue consists of sieve elements and phloem parenchyma.

3.1.2.4.7. The powdered leaf. The powdered leaf (Figure 7E) is pale green in colour, with a characteristic odour and slightly pungent taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of the upper and lower epidermis with polygonal isodiametric or slightly axially elongated cells having straight anticlinal walls in the upper epidermis and slightly wavy anticlinal walls in the lower epidermis. They are covered with thick smooth cuticle and showing anisocytic stomata.
2. Fragments of columnar, thin-walled palisade cells containing green plastids.

3. Numerous scattered non-glandular two-armed hairs and few glandular hairs with unicellular stalk and unicellular head and covered with smooth or warty cuticle.
4. Fragments of lignified xylem vessels with spiral and annular thickenings.

3.1.2.5. The fruit. A transverse section in the pericarp **(**Figure 8**)** shows an outer epicarp and an inner endocarp enclosing a moderately wide mesocarp. The mesocarp is differentiated into two distinct regions. The outer region is parenchymatous and is traversed by a main vascular strand forming a distinct ridge in each valve. The inner region of the mesocarp is formed of one row of sclerenchymatous cells. The endocarp is composed of large parenchyma cells containing mucilage.

3.1.2.5.1. The epicarp. The epicarp (Figures 8 and 9) is formed of tabular cells with straight anticlinal walls. They are covered with thick smooth cuticle. The stomata are anisocytic in type. Hairs are similar to hairs present on the surface of the young stem and the leaf.

3.1.2.5.2. The mesocarp. The outer region of the mesocarp (Figure 8B and C) is formed of 4 rows of tangentially elongated thin-walled parenchymatous cells. This region may reach 8 rows where it is traversed in the central region of the fruit valve by a main large collateral vascular bundle with the xylem to the inside and the phloem to the outside (Figure 8B). The

Table 1 Microscopical measurements of the different organs of *Farsetia aegyptia* Turra (in microns).

Item	L			W			H			D		
Root												
Cork cells	65	90	100	30	35	40	13	22	38			
Sclereids	35	180	240	15	25	60						
Wood fibres	270	400	450	13	15	17						
Vessels										25	50	75
Starch										3	7	10
Young stem												
Epidermal cells	60	78	108	24	42	84	37	40	56			
Glandular hair										37	42	50
Non-glandular hair	900	1125	1300	50	63	75						
Sclereids	100	113	115	35	40	90						
Wood fibres	800	840	900	12	18	30						
Vessels										6	14	25
Old stem												
Cork cells	38	42	60	21	25	30						
Sclereids	105	140	165	20	32	64						
Wood fibres	450	428	400	13	26	32						
Vessels										13	18	20
Starch										3	4	5
Leaf												
Upper epidermis	25	60	75	20	50	65	21	30	42			
Lower epidermis	19	42	50	15	38	42	14	20	40			
Glandular hair										35	40	51
Non-glandular hair	500	830	1083	41	48	50						
Palisade cells	35	38	41	5	8	11						
Stomata	25	26	28	15	22	25						
Vessels										7	11	15
Fruit												
Epicarp	30	66	83	23	33	50						
Sclerenchyma	200	230	250	15	20	35						
Endocarp							125	155	175			
Glandular hair												
Non-glandular hair	400	470	500	36	41	45	400					
Sclerenchyma of septum	66	85	104	4	6	9						
Vessels										7	9	10
Stomata	23	27	33	20	25	26						
Seed												
Epidermal cells	47	50	59	40	50	55	33	36	37			
Hypodermis	21	30	50	14	21	35	8	9	11			
Aleurone layer	13	23	27	3	10	16	11	16	17			
Polygonal cells of endosperm	20	35	45	15	25	35	17	22	23			
Embryo	27	33	45	12	17	25						

L, length; W, width; H, height; D, diameter.

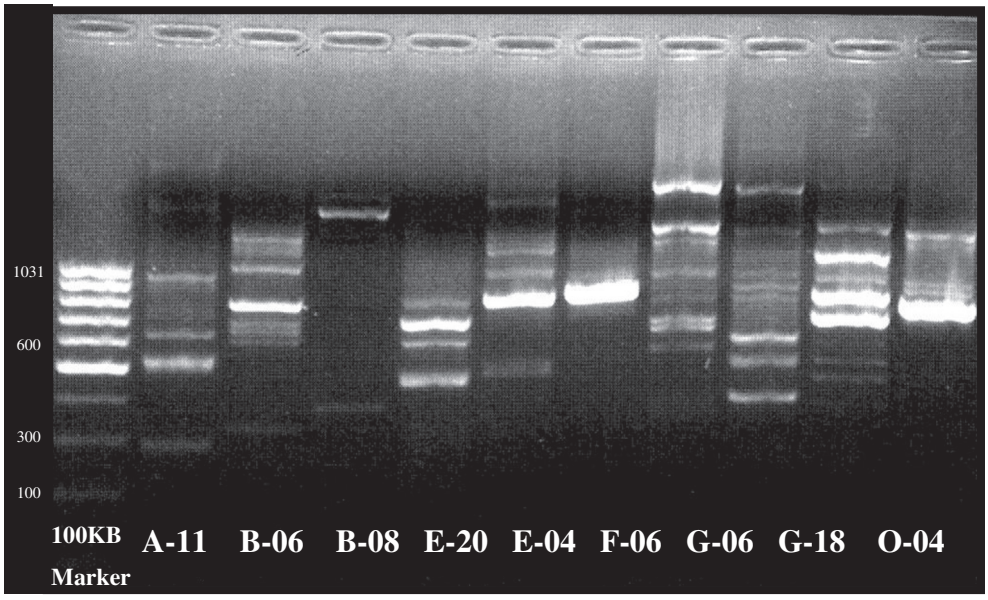

Figure 11 The RAPD–PCR products of *Farsetia aegyptia* Turra using ten decamer primers.

phloem consists of a soft tissue formed mainly of thin-walled parenchymatous cells, sieve tubes and companion cells. The xylem is formed of lignified spiral and annular vessels. The pericycle is parenchymatous. The outer region of mesocarp contains occasional scattered idioblasts of myrosin cells. The inner region (Figs. 8 and 9) is formed of one row of polygonal elongated lignified sclerenchymatous cells with wide or narrow lumina.

3.1.2.5.3. The endocarp. The endocarp (Figure 8B and C) is formed of one row of large columnar thin straight walled polygonal parenchyma cells containing mucilage.

3.1.2.5.4. The septum. The septum (Figs. 8D and 9) is formed of bundles formed of elongated pitted lignified sclerenchyma cells followed by one row of thin-walled elongated parenchyma cells.

3.1.2.5.5. The powdered fruit. The powdered fruit (Figure 9) is pale green to brownish green in colour, with slightly pungent taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of epicarp with polygonal slightly elongated cells having straight anticlinal walls, covered with thick smooth cuticle and showing anisocytic stomata with numerous non-glandular and few glandular hairs.
2. Fragments of lignified sclerenchymatous cells with wide or narrow lumina.
3. Fragments of annular and spiral xylem vessels.
4. Numerous scattered non-glandular unicellular calcified two-armed hairs and few glandular hairs with unicellular stalk and unicellular head, covered with smooth cuticle.
5. Fragments of elongated pitted sclerenchymatous cells of the septum.
6. Fragments of elongated thin-walled parenchyma cells of the septum.

3.1.2.6. The seed. A transverse section in the seed (Figure 10A) shows the testa which is narrow and composed of an epidermis and hypodermis. The testa is followed by the endosperm and the embryo.

3.1.2.6.1. The testa. The epidermis: The epidermis (Figure 10A and B) is formed of one row of large polygonal isodiametric cells with straight cellulosic anticlinal walls covered with thick smooth cuticle containing mucilage.

The hypodermis: The hypodermis (Figure 10A and B) is formed of one row of smaller tabular cells being polygonal isodiametric in top view with thick straight cellulosic anticlinal walls showing reddish brown content.

The endosperm: The endosperm (Figure 10A and B) is formed of an aleurone layer consisting of isodiametric thin-walled polygonal parenchymatous cells containing protein masses (stained yellow with picric acid in T.S.). The remainder of the endosperm is formed of 3–5 rows of thin-walled cellulosic polygonal cells.

The embryo: A transverse section in the cotyledon (Figure 10A and B) is formed of several rows of small isodiametric or slightly elongated thin-walled parenchyma cells with slightly wavy anticlinal walls filled with oil droplets (gives red with sudan III in T.S.) and protein masses.

3.1.2.6.6. The powdered seed. The powdered seed (Figure 10B) is pale orange brown in colour with slightly pungent odour and oily mucilaginous taste. Microscopically, it is characterized by the presence of the following:

1. Fragments of polygonal isodiametric cellulosic epidermal cells containing stratified mucilage.
2. Fragments of polygonal isodiametric cells of the hypodermis with thick straight cellulosic anticlinal walls showing reddish brown content.
3. Fragments of the aleurone layer showing thin-walled parenchyma containing protein masses.
4. Fragments of the endosperm showing thin-walled polygonal cells.
5. Fragments of isodiametric or slightly elongated thin-walled embryo cells with slightly wavy anticlinal walls filled with oil droplets and protein masses.
6. The microscopical measurements of the different elements are represented in Table 1.

Table 2 Molecular size in base pair of amplified DNA fragments produced by ten decamer primers in *Farsetia aegyptia* Turra.

Molecular size (bp)	A-11	B-06	B-08	E-20	E-04	F-06	G-06	G-18	O-04	Z-13
288	+	−	−	−	−	−	−	−	−	−
335	−	+	−	−	−	−	−	−	−	−
385	−	−	+	−	−	−	−	−	−	−
435	−	−	−	−	−	−	−	+	−	−
477	−	−	−	+	−	−	−	−	−	−
507	−	−	−	−	−	−	−	−	+	−
515	−	−	−	−	+	−	−	−	−	−
523	+	−	−	−	−	−	−	−	−	−
565	−	−	−	−	−	−	−	+	−	−
574	−	−	−	−	−	−	−	−	+	−
616	−	−	−	−	−	−	−	−	−	−
619	−	+	−	−	−	−	−	−	−	−
629	−	−	−	+	−	−	+	−	−	−
639	+	−	−	−	−	−	−	−	−	−
659	−	−	−	−	−	−	−	+	−	−
669	−	+	−	−	−	−	−	−	−	−
700	−	+	−	−	−	−	−	−	−	−
711	−	−	−	−	−	−	+	−	−	−
722	−	−	−	+	−	−	−	−	−	−
756	−	−	−	−	−	−	+	−	−	−
758	−	−	−	−	−	−	−	−	−	−
768	−	−	−	−	−	−	−	−	+	−
792	−	+	−	−	−	−	−	−	−	−
804	−	−	−	−	−	−	−	−	−	+
829	−	−	−	+	−	−	−	−	−	−
855	−	−	−	−	+	−	−	−	−	−
895	−	−	−	−	−	−	+	+	−	−
909	−	−	−	−	−	+	−	−	+	−
937	−	−	−	−	−	−	−	−	−	+
966	+	−	−	−	−	−	+	+	−	−
1012	−	−	−	−	−	−	−	−	−	+
1027	−	+	−	−	−	+	−	−	+	−
1059	−	−	−	−	+	−	+	+	−	−
1198	−	+	−	−	−	−	−	−	+	−
1216	−	−	−	−	−	−	−	+	−	−
1235	−	−	−	−	+	−	−	−	−	−
1273	−	+	−	−	−	−	−	−	−	−
1293	−	−	−	−	−	−	−	−	−	+
1333	−	−	−	−	−	−	+	−	−	−
1396	−	−	−	−	−	−	−	+	−	−
1418	−	−	−	−	−	−	−	−	−	+
1462	−	−	−	−	−	−	+	−	+	−
1554	−	−	+	−	−	−	−	−	−	−
1578	+	−	−	−	−	−	−	−	−	−
1757	−	−	+	−	−	−	−	−	−	−
1784	−	−	−	−	+	−	−	−	−	−
1927	−	−	−	−	−	−	+	+	−	−
1987	−	−	−	−	+	−	−	−	−	−
Total	5	8	3	4	6	2	9	9	7	5

(+), Presence of bands; (−), absence of bands.

3.2. DNA fingerprint

The DNA fingerprint of *F. aegyptia* Turra was carried out as a contribution to the macro- and micromorphological identification and characterization of the plant.

In this study the extracted DNA of the plant was amplified using ten decamer primers. The RAPD electrophoretic profile of the DNA sample showed distinguishable bands and generated 58 fragment patterns. The obtained banding profiles produced by the primers used in the RAPD analysis were represented in Figure 11. The distribution of these bands is illustrated in Table 2.

The ten primers of arbitrary sequences produced multiple band profiles with a number of amplified DNA fragments ranging from 9 when G-06 and G-18 were used to the least number of fragments being 2 when F-06 was used.

The primers G-06 and G-18 were found to be the most effective in the selective discrimination of *F. aegyptia* Turra by the production of 9 amplified DNA fragments each, followed by B-06 producing 8 amplified DNA fragments.

However, the primers F-06 and B-08 produced 2 and 3 amplified DNA fragments, respectively. Therefore, they can be considered of less contribution to the identification of *F. aegyptia* Turra.

4. Conclusion

F. aegyptia Turra is a cruciferous plant native to Egypt. This study aimed to characterize the plant on both the botanical and the genetic levels.

F. aegyptia Turra is characterized microscopically by the presence of myrosin cells and non-glandular branched unicellular two-armed hairs in the stem, leaves and fruit, while the root shows sclereids with a wide or narrow lumen and pitted lignified walls.

The DNA of *F. aegyptia* Turra was amplified using ten decamer primers to reveal RAPD fragments. The results suggest the use of primers G-06 and G-18 for the selective discrimination of *F. aegyptia* Turra.

5. Conflict of interest

None.

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