

Morpho-Anatomical Comparison of *Plantago ovata* Forssk. and *Plantago major* L. : Two Indigenous Traditional Medicinal Plants of Plantaginaceae

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Abstract

In this study seed morphology and anatomy of two species *Plantago ovata* Forssk and *Plantago major* L. belongs to Plantaginaceae family were studied. Both plants are important medicinal plants in Indian Pharmacopoeias. Macro- and micro-morphological characters, including seed shape, color, size, taste, epidermal cell, endosperm and embryo are analysed. Macroscopic characters like colour and shape, mucilaginous nature, surface, seed coat, seed coat cell shape, endosperm, endospermic cells, shape of embryo and depositions are showed major differences and these findings will help for the identification of both species.

1. Introduction

Worldwide around 275 annual and perennial species distributed in the *Plantago* genus belongs to the Plantaginaceae family. *Plantago* species have been used in the indigenous medicinal system and added in the various pharmacopoeias from the centuries ago due to their diverse properties (Sandra & Anabela, 2016). Most of the *Plantago* species are small, with elliptic leaves and spikes containing tiny flowers (Jong et al., 2018). Some species are particularly valuable in the nutraceutical and pharmaceutical industries due to the mucilaginous product (Psyllium) derived from the seed husk, which has been used as a functional food and dietary supplement to improve intestinal health (Sandra & Anabela, 2016). *Plantago* seeds contain 10-30% of hydrocolloid in the outer seed coat which can be separated into acidic and neutral polysaccharides and solution of *Plantago* gum is thixotropic where as its mucilage has super disintegrant property (Rai Muhammad et al., 2017). The World health Organization has approved the use of *Plantago* as laxative agent, to treat

hypercholesterolemia and to reduce the blood glucose (Kazhal et al., 2014).

There are several effective chemical constituents in *Plantago*, such as flavonoids, alkaloids, terpenoids, phenolic acid derivatives, iridoid glycosides, fatty acids, and polysaccharides. Among them, polysaccharides are the most abundant component (Shanshan et al., 2021). In the plant *Plantago ovata* contains mucilaginous polysaccharides (hemicelluloses), fatty oil, iridoids, prolein substances, L-arabinose, D-xylose, D-glucuronic acid and galactouric acid units (arabinoxilans) (Shalini et al., 2020). The plant *Plantago major* contains different compounds such as phenolic compounds (caffeic acid derivatives), flavonoids, alkaloids, terpenoids, vitamin C, antioxidants, anti-inflammatory agents, iridoid glycosides, fatty acids, polysaccharides and vitamins (Kazhal et al., 2014). *Plantago* species plays an important role in the management of certain ailments and diseases such as ulcers, bacterial and viral infections, diarrhoea, pain, inflammation, diabetes, obesity, constipation and cancer. The function

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and mechanism of polysaccharides, an important active component of *Plantago*, have been investigated and gradually clarified (Muhammad *et al.*, 2017).

In this study seed morphology and anatomy of two species *Plantago ovata* and *Plantago major* L. belongs to Plantaginaceae family were studied. Both plants are important medicinal plants in Indian Pharmacopeias. Macro- and micro-morphological characters, including seed shape, color, size, taste, epidermal cell, endosperm and embryo are analysed. Marked difference among the species noted with respect of considered traits and a key for the identification of the investigated taxa based on seed characters is provided.

2. Materials and Methods

2.1. Plant materials

In the present study selected mature dried seeds of two species of *Plantago* viz. *P. ovata* and *P. major* for pharmcognostic analysis and comparison.

a. *Plantago ovata*.

The herb distributed in North- West India, cultivated to a small extent in West Begal, Karnataka and Coromandal coast. The plant occurs during winter season. Flowering takes place during November to January while fruiting occurs during March-April.

Names in other languages

Arabic; BazrQatuna, Persian; Aspiyoos, Aspghol, Urdu; Aspaghul, Bengali; Eshopgol, English; Spogel seeds, Gujarati; Isaphgol, Hindi; Isbugol, Kannada; Isafgole, Malayalam; Karkata sringi, Tamil; Iskalvirai, Telugu; Isapghola.

b. *Plantago major*

The herb distribution in temperate and alpine himalayas, Assam, Konkan, Western Ghats and Nilgiris, Europe, Japan and North America.

Names in other languages:

Hindi: Lahuriya; English: Greater plantain, Plantain, Ribgrass, Waybred;

French: Grand Plantain; German: Grosser Wegerich.

2.2. Equipments Used

Normal compound microscope with camera attachment: Trinocular 'Leica' microscope attached with 'Leica DFC 295' digital camera connected to the computer was used for the observation and transferring microscopic images of the plants studied.

2.3. Histological studies.

Hand sections were stained with diluted aqueous safranin, mounted with glycerin and observed under the microscope. Histological microphotographs were transferred using the computer controlled microscopic system connected to a Canon digital camera.

2.4. Powder studies of useful part of the various samples of the source plants.

For examining the cell structure in powder form, materials were powdered sieved, stained with safranin stain, mounted in glycerin and observed under microscope transferred the images of powder characters to the computer using the computer controlled microscopic system.

3. Results and Discussion

3.1. Macroscopic characters

P. ovata: The drug consists of mature dried seeds of *Plantago ovata* Forsk. Syn. *P. ispaghula* Roxb. (Plantaginaceae), colour dull pinkish grey-brown, shape oval, heavy mucilaginous nature, taste mucilaginous, odourless, very slippery, ellipsoid to ovoid-ellipsoid, 2.5–3 mm, with a groove on ventral face; cotyledons vertical to ventral side, (Fig1).

P. major, The drug consists of mature dried seeds of *Plantago major* L. Seeds dull black, ovoid, ellipsoid, or rhomboid, 0.85 mm long, 4 to 8 angled, rugulose, ventral face prominent to slightly flat; mucilaginous nature of seeds mild, cotyledons parallel to ventral side (Fig. 1).

3.2. Microscopic characters

P. ovata seed transverse section shows albuminous nature, highly mucilaginous in nature and the epidermis swells greatly when seeds are soaked in water, seed coat swells and the seed get enveloped with a colorless mucilage, seed coat cell shape is angular, TS shows central core of endosperm and two fleshy cotyledons. The structure of seed coat is simple. The epidermis of the testa is composed of polyhedral cells, the walls of which are thickened by a secondary deposit, the source of mucilage. A thin brownish layer is found in between the epidermis and the albumin. The albumin is formed of thick-walled cells which are rich in matter like the fixed oil and proteins. The cells of embryo are parenchymatous and packed with aleurone grains (Fig 2).

P. major seed transverse section shows albuminous nature, mucilaginous in nature and the epidermis swells slowly when seeds are soaked in water, epidermis arranged in with small many ridges and grooves, seed coat swells and the seed get enveloped with a colorless mucilage, seedcoat cell shape is irregular, TS shows central core of endosperm and two fleshy cotyledons. The structure of seed coat is simple. The epidermis of the testa is composed of polyhedral to oval shaped cells, filled with oil globules and mucilage, A thin dark brownish layer is found in between the epidermis and the albumin. The albumin is formed of thick-walled cells which are rich in matter like the fixed oil and proteins. The cells of embryo are parenchymatous and packed with aleurone grains (Fig 4).

3.3. Powder characters

P. ovata seed powder creamy brownish colored with somewhat sweet & mucilaginous taste but without any characteristic odour was observed. prismatic type crystals, fragment of cotyledons, mucilage, fragment of epidermal cells, fragment of endosperm, fragment of cotyledon, non-lignified fibre, fragment of endosperm, oil filled cells, starch grains were observed (Fig 3).

P. major seed powder brownish black colored with somewhat mucilaginous taste but without any characteristic odour was observed. prismatic type crystals, fragment of epidermis, oil globules, mucilage, oil filled cells from endosperm, fragment of cotyledon, fragment of endospermic cells with oil globules, endosperm cells without cell inclusions, endosperm cells with cell inclusions, fragment of endosperm, oil filled cells, cells from epidermis, group of cells from cotyledon, cells from testa were observed (Fig 5).

From the study observation both seeds of plant *P. ovata* and *P. major* showing concavo convex, ovate shape, odourless and mucilage taste, epidermal layer contain mucilaginous cells walls break down to form layers of mucilage when brought into contact with water. A broad endosperm with thick-walled cells filled with fixed oil and aleurone grains. Embryo extending through the centre. Colour and size various in both seed species. Seed coat morphology is known to be an excellent character for taxonomic and evolutionary studies (Ashutosh et al., 2017), similarly in this studied species showed particular identification key characters like mucilaginous nature, water absorbance nature, large endosperm with thick-walled cells, seed coat cells, cell content. The present study is helpful in species identification on the basis of micro-morphological seed characters.



Fig. 1 Seeds of *Plantago ovata* (A); *Plantago major* (B)

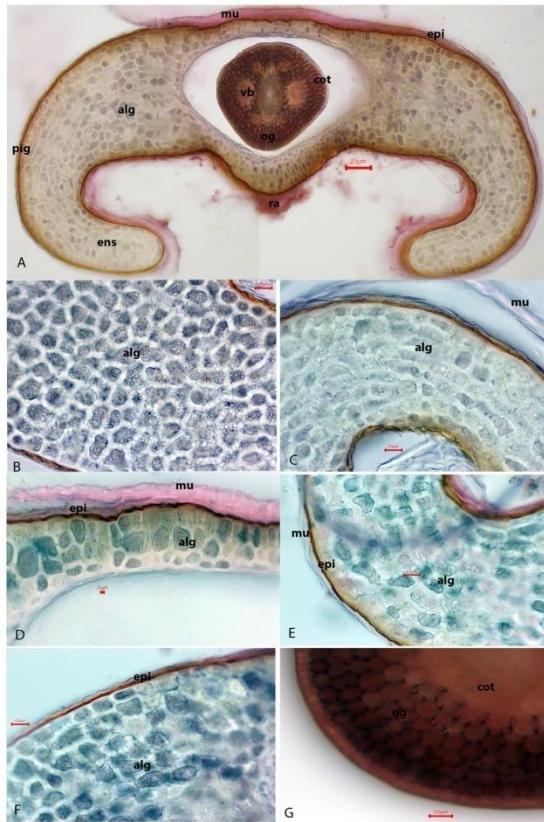


Fig 2: T.S. of *Plantago ovata* A; T.S. of *Plantago ovata* seed, B;C;D;E;F; enlarged view of boat shaped T.S. G; T.S of embryo (alg; aleurone grains, cot; cotyledons; l; end; endosperm, epi; epidermis of testa, mu; mucilage, og; oil globule, pig; pigments, ra; raphe, vb; vascular bundle)

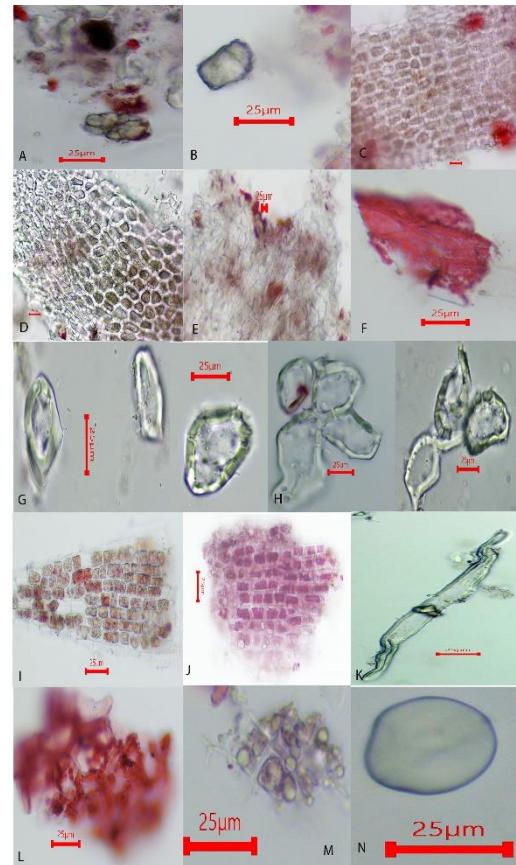


Fig 3: Powder of *Plantago ovata* A&B; prismatic type crystals, C&D; fragment of cotyledons, E; mucilage, F; fragment of epidermal cells, G&H; fragment of endosperm, I&J; fragment of cotyledon, K; non lignified fibre, L; fragment of endosperm, M; oil filled cells, N; a starch grains.

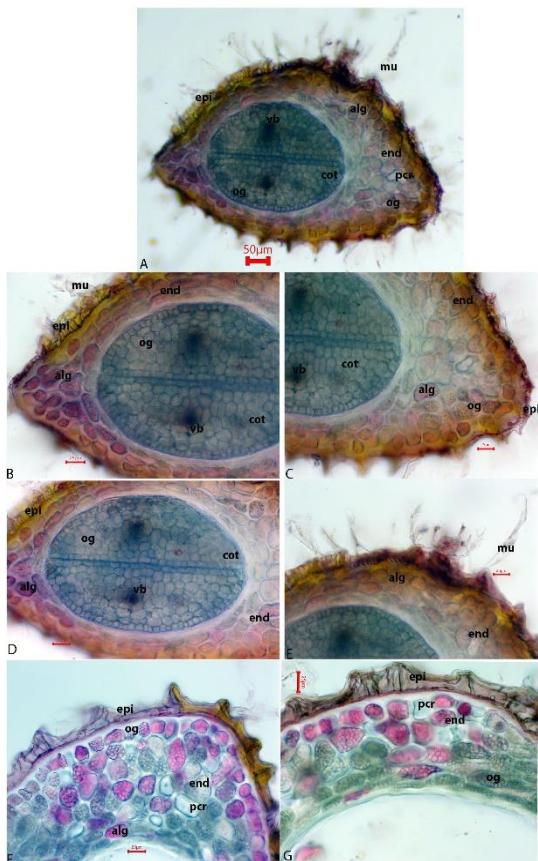


Fig 4: T.S. of *Plantago major*, A; T.S. of *Plantago major* seed, B;C;D;E;F&G; enlarged view of seed T.S, G; T.S of embryo (alg; aleurone grains, cot; cotyledons; end; endosperm, epi; epidermis of testa, mu; mucilage, og; oil globule, pcr; prismatic crystals, pig; pigments, vb; vascular bundle)

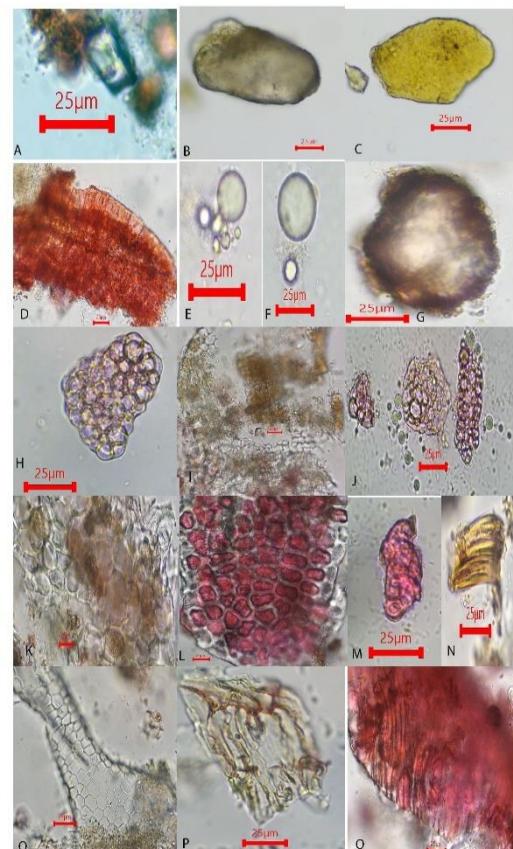


Fig 5: Powder of *Plantago ovata* A&B; prismatic type crystals, C&D; fragment of epidermis, E&F; oil globules, G; mucilage, H; oil filled cells from endosperm, I; fragment of cotyledon, J; fragment of endospermic cells with oil globules, K; endosperm cells without cell inclusions, L; endosperm cells with cell inclusions, M; oil filled cells, N; Cells from epidermis, O; Group of cells from cotyledon, P&Q; cells from testa.



4. Conclusion

The comparative evaluation of seed morphology and anatomy in *Plantago ovata* and *Plantago major* reveals significant macroscopic and microscopic differences between the two species. Variations in seed-coat structure, mucilage formation, epidermal cell patterns, endosperm characteristics, and embryo morphology provide reliable diagnostic markers for distinguishing these medicinally important plants.

5. References

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These findings enhance the accuracy of species identification and support their correct utilization in Indian Pharmacopeias and related pharmacognostic applications. The present study also revalidates the scope of seed micro-morphological studies for the development of species-specific marker keys and will be helpful in identification of therapeutically and economically important seeds at market and laboratory level.

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