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SEEDLING MORPHOLOGICAL STUDY OF SOME COMMON ANTI-DIABETIC PLANTS WITH REFERENCE TO ITS TAXONOMIC POTENTIAL

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ABSTRACT

Diabetes is a growing health concern worldwide and now emerging as an epidemic world over. The management of diabetes is still a major challenge. Thus there is great demand for research on natural products with anti-diabetic properties. Numerous studies have confirmed the benefits of medicinal plants with anti-hyperglycemic effects in the management of diabetes mellitus. In this paper, we address the identification of some anti-diabetic plants at the juvenile stage. Seedling morphology of ten taxa has been studied which are known to cure diabetes. The characters of paracotyledons and eophylls provide important informations which have been used in construction of artificial keys for identification purpose. The objective of this work is to provide seedling data for the identification of these plants at the seedling stage for sustainable consumption.

KEYWORDS: Artificial key, seedling morphology, diabetes.

INTRODUCTION

The study of seedling morphology has become a current trend in taxonomic research. The taxonomic significance of seedling derives principally from its morphology. Juvenile stages of plants are often so strikingly different from adult stage that even with good field knowledge of plants it is hard to correlate the seedlings with an adult plant. Seedlings are rather infrequently used as sources of taxonomic characters for the purpose of systematic considerations (Canne, 1983; Ahammed,, 1996). As such any group of taxa, either in part or as a whole, which are easily available locally can be considered for the preliminary study of morphology of seedlings in relation to their systematic reliability.

Diabetes is a chronic metabolic disorder that poses a major challenge worldwide. Currently in India the number of people with diabetes is around 40.9 million and it is expected1 to rise to 69.9 million by 2025 (Noor *et al*, 2013). India has emerged as the diabetic capital of the world. Unless urgent preventive steps are taken, it will become a major health problem. The Indian Diabetes Federation (IDF) estimated 3.9 million deaths for the year 2010, which represented 6.8% of the total global mortality. More than 1200 species of organisms have been used ethnopharmacologically or experimentally to treat symptoms of diabetes mellitus. They represent more than 725 genera in 183 families, extending phylogenetically all the way from marine algae and fungi to advanced plants such as the composites (Marles and Fanswort, 1995)

In view of the above, an attempt has been made to study the significance of seedling morphology of some of the antidiabetic plants. Seedling characters are as important and reliable as that of floral one in the delimitation of species, genera and sometimes families. The characters of seedlings are limited in number, but their diversity is large and thus their assemblage serves the purpose of identification.

MATERIALS AND METHODS

In the present investigation seedlings of ten taxa were selected. The list of investigated taxa is given below:

1.Acacia arabica (L.) Delile
2. *Achyranthes aspera* L.
3. *Andrographis paniculata* (Burm.f.) Wall. ex Nees
4. *Azadirachta indica* A.Juss.
5. *Catharanthus roseus* (L.) G.Don
6. *Eclipta prostrata* (L.) L.
7.*Ocimum sanctum* L.
8. *Phyllanthus amarus* Schum. & Thonn.
9. *Tecoma stans* (L.) Juss. ex Kunth
10. *Terminalia catappa* L.

The specimens were collected from different localities of Kolkata and adjoining areas. The specimens were photographed, and documented in the form of herbarium sheets. They were compared and identified with the help of seedlings raised from identified seeds. At least five to ten specimens of each growth forms were studied from various habitats. The specimens were described following the terminology as proposed by Burger (1972),

Hickey (1973) and Vogel (1980). Based on these characters an artificial key was constructed which helps in the easy identification of the taxa.

Diabetic potential of the plants(Kooti et al, 2016; Mukesh R, Namita P, 2013.

Acacia Arabica.

In a study that was done to evaluate the anti-diabetic activity of the acacia plant, oral administration of 200 mg/kg and 100 mg/kg of *Acacia arabica* bark extract to streptozotocin (STZ)-induced diabetic rats over a 21 days period increased serum insulin. In addition, high serum glucose and insulin resistance decreased, and the lipid profile improved. This plant contains polyphenols, tannins, and flavonoids (for example, quercetin). The presence of these substances with antioxidant properties is an explanation for anti-diabetic effects of this plant. The *Acacia Arabica* extract improves plasma glucose levels, metabolic disorders in lipid metabolism, and oxidative stress in STZinduced diabetic rats (11). Also, the chloroform extract of *Acacia arabica* bark was used for 2 weeks in diabetic rats, significantly reduced the blood glucose level and improved the cholesterol, triglyceride, HDL, and LDL levels

Achyranthes aspera

The ethanolic extract of *Achyranthes aspera* leaves (1000 mg/kg) used in STZ-induced diabetic rats significantly reduced their blood glucose level. This is probably due to the inhibition of glucose absorption from the intestine or because of an increase in glucose transport from the blood.

Andrographis paniculata

Oral administration of ethanolic extract derived from the aerial parts of *Andrographis paniculata* (different doses of 0.1, 0.2 and 0.4 g/BW) caused a significant reduction in levels of the serum glucose in STZ diabetic rats. However, the effect was not seen in normal rats. This extract and anti-diabetic drugs dramatically reduced the activity of liver glucose-6-phosphatase. Further research has shown that the extract reduces the level of fasting serum triglyceride by 49.8%, while metformin drugs reduces levels by 27.7%, but neither the extract or metformin affect cholesterol levels. In addition, further studies concluded that the ethanolic extract of this plant has anti-diabetic activity that is involved in the increase of glucose metabolism.

Azadirachta indica

Administration of the leaf extract and seed oil for 4 weeks reduced the blood glucose levels in alloxan diabetic rabbits. This extract had similar effects as the anti-diabetic drug glibenclamide. The neem extract can control blood glucose and appears to be helpful in preventing or delaying the onset of diabetes (23). In another study, the antidiabetic effects of the neem was evaluated and it was found that the administration of a single dose of aqueous extract of the bark and root (250 mg/kg) can decrease urea (13%), triglycerides (32%), cholesterol (15%), glucose (18%), lipids (15%), and creatinine (23%) in diabetic rats (24) for 24 hours after treatment.

Catharanthus roseus

The possible antidiabetic and hypolipidemic effect of *C. roseus* (Catharanthus roseus) leaf powder in diabetic rats was studied. In diabetic rats (D-group) the plasma glucose was increased and the plasma insulin was decreased gradually. In the diabetic-treated group lowering of plasma glucose and an increase in plasma insulin were observed after 15 days and by the end of the experimental period the plasma glucose had almost reached the normal level, but insulin had not. The significant enhancement in plasma total cholesterol, triglycerides, LDL and VLDL-cholesterol, and the atherogenic index of diabetic rats were normalized in diabetic-treated rats. Decreased hepatic and muscle glycogen content and alterations in the activities of enzymes of glucose metabolism (glycogen phosphorylase, hexokinase, phosphofructokinase, pyruvate kinase, and glucose-6-phosphate dehydrogenase), as observed in the diabetic control rats, were prevented with *C. roseus* administration. Results demonstrated that *C. roseus* with its antidiabetic and hypolipidemic properties could be a potential herbal medicine in treating diabetes.

Eclipta alba is an herbaceous plant found in the tropical and subtropical regions of South America, Asia, and Africa Many chemical compounds, including flavonoids, alkaloids, tryterpens, and other glycosides, have been purified from this plant (45). It is considered to be an important hypoglycemic agent in rural areas of southern India. Oral administration of leaf suspension of *E. alba* (2 and 4 gr/kg) for 60 days caused a significant reduction in blood glucose, glycosylated hemoglobin, glucose-6-phosphatase, and fructose-1, 6 bisphosphatase in alloxan-induced diabetic rats, however the hexokinase concentrations in the liver increased.

Ocimum sanctum

The leaves of this plant are traditionally used in treating diabetes. Consuming doses of *Ocimum sanctum* (OS) leaf at 2 gr/kg for 30 days in the group of albino rabbits caused a sharp reduction in glucose level and the level of antioxidant enzymes and glutathione increased, while lipid peroxidation decreased by using the plant leaf. For this reason, the hypoglycemic activity of the plant is believed to be related to the adjustment of the cellular antioxidant system (57). In another study, the ethanolic extract of OS leaves caused a significant reduction in blood glucose levels in normal and alloxan-induced diabetic rats.

Phyllanthus amarus

Phyllanthus amarus is a medicinal plant known as a hypoglycemic factor in central and southern India. Oral administration of ethanolic extract from the leaves (400

mg/kg/BW) for 45 days caused a significant reduction in blood glucose levels in alloxan-induced diabetic mice and led to a significant improvement in the body weight of diabetic mice. Also, there was a reduction in glucose-6-phosphatase and fructose 1, 6 di phosphatase activities in the liver. The glucokinase activity, in comparison with control group, increased during treatment in the liver of thediabetic rats.

Tecoma stans

The study present evidence that the main antidiabetic effect of Tecoma aqueous extract is due to intestinal alpha-glucosidase inhibition by decreasing the postprandial hyper-glycaemia peak; in addition, Tecoma aqueous extract sub-chronic administration reduces triglycerides and cholesterol, without modifying fasting glucose.

Terminalia catappa

n view of alleged antidiabetic potential, effect of the petroleum ether, methanol, and aqueous extracts of *Terminalia catappa Linn* (combretaceae) fruit, on fasting blood sugar levels and serum biochemical analysis in alloxan-induced diabetic rats were investigated. All the three extracts of *Terminalia catappa* produced a significant antidiabetic activity at dose levels 1/5 of their lethal doses. Concurrent histological studies of the pancreas of these animals showed comparable regeneration by methanolic and aqueous extracts which were earlier, necrosed by alloxan.

Description of Seedlings

Acacia arabica

(Up to 8th leaves stages)

Seedling epigeal, phanerocotylar. Taproot strongly elongating, 5.4 cm-5.5 cm long, soft, greyish white, curved, glabrous; side roots many, unbranched. Hypocotyl strongly elongating, 3.5 cm-4.0 cm long, terete, pinkish, glabrous. Paracotyledons two, opposite, oblique, stipulate, sessile, coriaceous, pubescent; blade ovate-elliptic (0.7 cm-0.8 cm x 0.4 cm-0.5 cm); base deeply cleft & auricled, clasping the axis, apex rounded, margin entire; primary vein one, simple craspedodromous; surface glabrous. Internodes terete, green, soft, distantly minutely hairy; first internode 0.2 cm-0.3 cm long, second one 0.2 cm-0.4 cm long; next internodes elongating,, slender. First two leaves alternate, compound, first uniparipinnate, second biparipinnate, herbaceous, stipulate, petiolate; petiole 0.5 cm-0.6 cm, terete, pubescent; blade leaflet pairs 5-6, leaflet linear oblong (1.0 cm-1.3 cm x 0.5 cm-0.6 cm), base assymetric, apex acute, margin entire; primary vein one, simple craspedodromous; surface hairy. Subsequent leaves alternate, third and fourth leaves as in second leaf, petiole becoming more flattened, 1.4 cm-1.8 cm long, leaflet absent in fifth and onwards leaves, petiole becoming highly flattened forming a leaf-like green lanceolate structure (phylloclade). Other characters almost same as that of first two leaves. (Pl. I: a).

***Achyranthes aspera* L.**

(Upto 4th leaves stages)

Seedling epigeal, phanerocotylar. Taproot strongly elongating, 1.8 cm-2.5 cm long, creamish, curved, glabrous; side roots few, unbranched. Hypocotyl shortly elongating, 1.2 cm-1.5 cm long, terete, creamish, scabrous. Paracotyledons two, opposite, herbaceous, exstipulate, petiolate; petiole 0.3 cm-0.4 cm, glabrous; blade lanceolate (2.4 cm-2.5 cm x 0.5 cm-0.6 cm); base cuneate, apex acute, margin entire; primary vein one, hyphodromous; surface glabrous. Internodes terete, hirsute; first internode 0.5 cm-1.5 cm long, second one 3.2 cm-4.6 cm; next internodes slightly longer than first one. First two leaves alternate, simple, herbaceous, exstipulate, petiolate; petiole 0.2 cm-0.5 cm, flat, hirsute; blade elliptic (3.4 cm-5.0 cm x 2.7 cm-2.8 cm),base cuneate, apex obtuse, margin entire, primary vein one, brochidodromous; surface glabrous. Subsequent leaves alternate, simple, blade ovate-elliptic, margin slightly undulate, surface scarcely hairy, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 10: A-G; Pl. II: a).

Specimens examined: Sanyal, 1596, Salt Lake Sector II; Sanyal, 1681, Salt Lake Sector V; Sanyal, 1793, Salt Lake Sector I.

Andrographis paniculata (Burm. f.) Wall. ex Ness in Wall.,

(Up to 6th leaves stages)

Seedling epigeal, phanerocotylar. Taproot shortly elongating, 0.5 cm-1.5 cm, hardy, creamy white, curved, glabrous; side roots brown, branched. Hypocotyl strongly elongating, 2.0 cm-3.0 cm long, terete, glabrous. Paracotyledons two, opposite, exstipulate, petiolate; petiole 0.1 cm-0.4 cm, glabrous; blade suborbicular (0.5 cm-1.0 cm x 0.5 cm-1.0 cm); base ±truncate, apex shallowly retuse, margin entire; primary vein one, brochidodromous; surface glabrous. Internodes terete, soft, glabrous; first internode 1.0 cm-1.6 cm long, second one 1.5-1.8 cm long; next internodes almost same as that of first one. First two leaves opposite, simple, exstipulate, petiolate; petiole 0.3 cm-0.4 cm, terete, glabrous; blade ovate (0.6 cm-1.2 cm x 0.4 cm-0.6 cm), base ±rounded, apex acute, margin entire, glabrous; primary vein one, brochidodromous; surface glabrous. Subsequent leaves opposite decussate, ovate-elliptic, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs.1: A-C; Pl. I: a).

Specimens examined: Sanyal, 1756, Salt Lake Sector II; Sanyal 1584, Salt Lake Sector III; Sanyal, 2158, Salt Lake Sector IV.

***Azadiracta indica* A. Juss.**

(Up to 4th leaves stages)

Seedling epigeal, phanerocotylar. Taproot strongly elongating, 2.8 cm-4.5 cm long, hardy, creamy white, curved, glabrous; side roots many, branched. Hypocotyl strongly elongating, 4.6 cm-7.5 cm long, terete,

moderately hardy, brownish, glabrous. Paracotyledons two, opposite, exstipulate, petiolate; petiole 0.2 cm-0.3 cm, glabrous; blade spathulate (1.4 cm-1.7 cm x 0.7 cm-0.8 cm); base cuneate, apex obtuse, margin entire; primary vein one, brochidodromous; surface glabrous. Internodes terete, green, soft, hirsute; first internode 2.9 cm-5.0 cm long, second one 1.2 cm-1.8 cm long; next internodes almost equal to that of first one. First two leaves opposite, compound, trifoliolate to pentafoliolate, herbaceous, exstipulate, petiolate; petiole 0.9 cm-1.8 cm, terete, pubescent; terminal leaflets ovate-lanceolate (4.5 cm-7.5 cm x 1.8 cm-2.1 cm), lateral leaflets comparatively smaller (2.5 cm-4.6 cm x 0.6cm-0.9 cm), base of leaflets cuneate, apex acuminate, margin serrate and lobed, hairy; primary vein one, brochidodromous; surface glabrous. Subsequent leaves alternate, imparipinnate with terminal leaflets and two pairs of sessile leaflets, increasing in length,. Other characters almost same as that of first two leaves. (Figs. 98: A-B; Pl. XI: g).

Specimens examined: Sanyal, 1696, Salt Lake Sector II; Sanyal, 2182, Salt Lake Sector III; Sanyal, 2213, Salt Lake Sector V.

Catharanthus roseus (L.) G.Don
(Up to 6th leaves stages)
Seedling epigeal, phanerocotylar. Taproot shortly elongating, 0.7 cm-1.2 cm, creamish, soft, slender glabrous; side roots branched. Adventitious roots arising from the hypocotyls and lower nodes, shortly elongating, 1.5 cm-2.5 cm. Hypocotyl shortly elongating, 0.4 cm – 0.6 cm, terete, greenish, glabrous. Paracotyledons two, opposite, exstipulate, petiolate; petiole 0.05 cm-0.1 cm, glabrous; blade obovate (0.17 cm-0.19 cm x 0.06 cm-0.08 cm); base cuneate, apex obtuse, margin entire; veins inconspiquous; surface, glabrous; Internodes terete, glabrous; length of first internode 0.5cm-1cm; next internodes same as that of first one. First two leaves opposite, simple, herbaceous, exstipulate, petiolate; petiole 0.05 cm-0.1 cm, flattened, hispidulous; blade cordate to cordate-ovate (0.3 cm-0.4 cm x 0.1 cm-0.18 cm), base cuneate, apex acute, margin irregularly crenate; primary vein one, hyphodromous; surface glabrous. Subsequent leaves opposite decussate; gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 123: A-G).

Specimens examined: Sanyal 1567, Kalyanpur; Sanyal 1698, Baidyabati; Sanyal 2187, Salt Lake.

***Eclipta prostrata* (L.) L.**
(Up to 4th leaves stages)
Seedling epigeal, phanerocotylar. Taproot shortly elongating, 0.8 cm-1.5 cm, soft, creamish white, curved, glabrous; side roots many, branched. Hypocotyl shortly elongating, 0.6 cm-1.0 cm, terete, soft, lower part whitish, upper part green, glabrous. Paracotyledons two, opposite, exstipulate, short petiolate; petiole 0.2 cm-0.3 cm, pubescent; blade oblong (0.3 cm-0.5 cm x 0.2 cm-0.3 cm); base cuneate, apex rounded, margin entire; primary vein one, semicraspedodromous; surface pubescent; Internodes terete, green, soft, glabrous; first internode 0.5 cm-1.0 cm long, second one 1.6 cm-1.8 cm long; next internodes almost equal to that of first one. First two leaves opposite, simple, herbaceous, exstipulate, petiolate; petiole 1.5 cm-1.6 cm, terete, glabrous; blade ovate (0.7 cm-1.0 cm x 0.5 cm-0.7 cm), base cuneate, apex acute, margin entire, hairy; primary vein one, semicraspedodromous; surface hairy. Subsequent leaves opposite decussate, blade elliptic, base attenuate, apex acute, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 28: A-D; Pl. IV: a).

Specimens examined: Sanyal, 1616, Salt Lake Sector V; Sanyal, 2108, Salt Lake Sector III; Sanyal, 2149, Salt Lake Sector IV.

***Ocimum sanctum* L.**
(Up to 4th leaves stages)
Seedling epigeal, phanerocotylar, aromatic. Taproot shortly elongating, 3.0cm-4.5cm, creamish, straight, glabrous; side roots branched. Hypocotyl shortly elongating, 1.3cm –1.5cm, terete, greenish, pubescent. Paracotyledons two, opposite, herbaceous, exstipulate, petiolate; petiole0.3cm-0.4cm, hairy; blade deltoid (0.4cm-0.5cm x 0.4cm-0.5cm); base truncate, apex retuse, margin entire; primary vein one, brochidodromous; surface glabrous. Internodes very shortly elongating, first internode terete, next angular, hairy; first internode 0.9cm-1cm, second one 1.2cm-1.5cm, next internodes almost equal to that of second one. First two leaves opposite, simple, herbaceous, exstipulate, petiolate; petiole 1.7cm-1.8cm, hairy; blade ovate- oblong (1.5cm-1.9cm x 1cm-1.1cm), base rounded, apex obtuse, margin undulate; primary vein one, simple craspedodromous; surface hairy. Subsequent leaves opposite decussate; blade ovate-oblong, gradually increasing in size. Other characters same as that of first two leaves. (Pl.Ih)

Specimens examined: Sanyal, 1616, Salt Lake Sector V; Sanyal, 2108, Salt Lake Sector III; Sanyal, 2149, Salt Lake Sector IV.

***Phyllanthus amarus* Schum. & Thonn.**
(Up to 6th leaves stages)
Seedling epigeal, phanerocotylar. Taproot shortly elongating, 1.0cm-1.5 cm, white, soft, slender glabrous; side roots few, shortly branched. Hypocotyl shortly elongating, 1.2 cm – 1.5 cm, terete, reddish green, glabrous. Paracotyledons two, opposite, exstipulate, petiolate; petiole 0.1 cm, glabrous; ovate (0.2 cm-0.3 cm x 0.2 cm-0.3 cm); base subrounded, apex rounded, margin entire; primary vein one, hyphodromous. Internodes terete, green, glabrous, soft, length of first internode 0.4 cm-0.5 cm, second one 0.2 cm-0.3 cm; next internodes same as that of first one. First two leaves alternate, simple, herbaceous, stipulate; stipule triangular

lanceolate, apex acuminate, petiolate; petiole 0.05 cm-0.07 cm, terete, glabrous; blade obovate (0.4 cm-0.5 cm x 0.1 cm-0.3 cm), base cuneate, apex subtruncate, margin entire; primary vein one, brochidodromous; surface glabrous. Subsequent leaves wide obovate, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 53: A-E; Pl. VI: h).

Specimens examined: Sanyal, 1580, Salt Lake Sector -I; Sanyal, 1675, Salt Lake Sector III; Sanyal, 2124, Salt Lake Sector V.

***Tecoma stans* (L.) Juss. ex Kunth**

(Up to 8th leaves stages)

Seedling epigeal, phanerocotylar. Taproot strongly elongating, 3.5 cm-9.0 cm long, moderately hardy, creamy white, curved, glabrous; side roots few, shortly branched. Hypocotyl strongly elongating, 2.5 cm-4.0 cm long, terete, brownish, hairy. Paracotyledons two, opposite, exstipulate, short petiolate; petiole ±0.1 cm, glabrous; blade bilobed, much wider than long, (1.0 cm-1.1 cm x 1.7 cm-1.9 cm); base subtruncate, apex broadly emarginate, margin entire; primary vein one, veins inconspicous; surface glabrous. Internodes terete, green, soft, hirsute; first internode 0.8 cm-2.2 cm long, second one 0.5 cm-0.7 cm long; next internodes almost equal to that of first one. First two leaves opposite, simple, herbaceous, exstipulate, petiolate; petiole 0.3 cm-0.5 cm, terete, glabrous; blade ovate (2.1 cm-3.3 cm x 1.3 cm-1.8 cm), base cuneate, apex acute, margin serrate, hairy; primary vein one, brochidodromous; surface hairy. Subsequent leaves opposite, blade elliptic-oblong, simple, compound, imparipinnate from 10th-13th leaves stage, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 18: A-C; Pl. II: i).

Specimens examined: Sanyal, 1540, Salt Lake Sector II; Sanyal, 1609, Salt Lake Sector III; Sanyal, 2103, Salt Lake Sector IV.

***Terminalia catappa* L.**

(Up to 6th leaves)

Seedling epigeal, phanerocotylar. Taproot strongly elongating, 3.0 cm-4.5 cm long, hardy, curved, glabrous; side roots many, unbranched. Hypocotyl strongly elongating, 6.0 cm-10.4 cm long, terete, brownish, pubescent. Paracotyledons two, opposite, exstipulate, petiolate; petiole 0.9 cm-1.0 cm, petiole flat, pubescent; blade flabellate (2.6 cm-2.9 cm x 5.2 cm-5.3 cm); base ±truncate, apex truncate, margin entire; primary vein three, actinodromous; surface glabrous. Internodes terete, green, soft, glabrous; first internode 0.3 cm-0.4 cm long, second one 0.5 cm-0.7 cm long; next internodes almost equal to that of first one. First two leaves alternate, simple, herbaceous, exstipulate, short petiolate; petiole 0.7 cm-0.9 cm, terete, glabrous; blade obovate (4.0 cm-6.4 cm x 2.5 cm-3.5 cm), base cuneate, apex acuminate, margin entire, glabrous; primary vein one, semicraspedodromous; surface hairy. Subsequent leaves alternate, gradually increasing in size. Other characters almost same as that of first two leaves. (Figs. 25: A-C; Pl. III: g).

Specimens examined: Sanyal, 1562, Salt Lake Sector II; Sanyal, 1669, Salt Lake Sector I; Sanyal, 1779, Salt Lake Sector II.

Key to the investigated taxa

1. First two leaves alternate
2. Leaves compound, first unipinnate, second bipinnate,petiole becoming flattened to form phylloclade..... .....*Acacia arabica*.

2a. Leaves simple.

3. Paracotyledons lanceolate or ovate.
4. Paracotyledons lanceolate, subsequent leaves ovate-elliptic, margin slightly undulate, surface scarcely hairy..... *Achyranthes aspera.*

4a. Paracotyledons ovate, subsequent leaves obovate, margin entire, surface glabrous..... .....*Phyllanthus amarus.*

3a. Paracotyledons flabellate, first two leaves obovate, base cuneate, apex acuminate, venation semicraspedodromous.....*Terminalia catappa* 1a. First two leaves opposite.

5. Leaves simple
6. Paracotyledons suborbicular, brochidodromous venation....*Andrographis paniculata*.

6a. Paracotyledons obovate or oblong.

7. Paracotyledons obovate, apex obtuse……..*Catharanthus roseus.*

7a. Paracotyledons oblong or deltoid.

8. Paracotyledons oblong, apex rounded……*Eclipta prostrata.*

8a. Paracotyledons deltoid, apex retuse…….*Ocimum sanctum.*

5a.Leaves compound.

7. First two leaves trifoliolate to pentafoliolate, terminal leaflets ovate-lanceolate, lateral Smaller..... ..*Azadiracta indica.*

7a. First two leaves simple, Subsequent leaves compound from 10th-13th leaves stage…… ……..*Tecoma stans.*

DISCUSSION

The seedling morphology of the investigated taxa exhibits some important characters. Using these features the investigated species can be distinguished with the help of artificial key. Based on seedling morphological features, all the taxa of the present study can be identified. The distinguishing characters of the seedlings include the following: germination pattern of seed (phanerocotlar or cryptocotylar), phyllotaxy of first two leaves (alternate or opposie), nature of eophylls (simple or compound), number and distribution of primary veins of paracotyledons, shape, base and apex of

paracotyledon, first two leaves and subsequent leaves.

Although many plant species have been validated fo rtheir anti-diabetic properties and related complications, there is a need for modern research in the identification of plants at seedling stage. A large-scale production of quality plant material and innovative procedures eradicates these medicinal plant species from nature so conservation of these plants at seedling stage will help in the sustainable development.

CONCLUSION

This paper discussed selective medicinal plant species from India and showed that they have anti-diabetic activity. In addition, an artificial key was prepared with the help of diagnostic seedling characters which provide easy identification of these plants at juvenile stage much before flowering and fruiting.

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