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RESEARCH ARTICLE

Studies on the Sclereids Diversity and Distribution Pattern in the Different Plant Organs (leaves, stems and fruits) of some Selected Medicinally Viable Angiospermic Taxa in Eastern India: A Systematic Approach

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ABSTRACT

Sclereids or stone cells in the plant organs have great value in plant systematics studies. A comparative micro- morphological study of plant sclereids of 26 genera belonging to 15 families (each 3 members from Rosaceae, Sapotaceae, 2 members from Cucurbitaceae, Lauraceae, Euphorbiaceae, 1 member from Annonaceae, Ebenaceae, Magnoliaceae, Fabaceaewas done. Five types of sclereids were observed viz. Astro sclereids, Brachy sclereids, osteo sclereids, Macro Sclereids and Tricho Sclereids. Sclereids were associated with fibrous tissue which were elongated in structure and thick walled than the fibrous cells, but thickness of the wall of sclereids were not uniform. Among these 5 types of sclereids brachysclereid are more common in case of fresh fruits than other plant parts. The most diversified sclereids were observed in the aquatic angiosperms like Nelumbo nucifera, Nymphoides cristatum and Nymphaea nouchali. The structure, shape and size of sclereids varied between the different families and even within the family between the various genera. It has been observed that a combination of the typological diversity and surface distribution pattern could be utilized as an aid in the distributionof the taxon at the specific and subspecific level.

***KEY WORDS**: Micro-morphological studies, sclereids, taxonomic tools*

INTRODUCTION

Sclereids can be found in many different parts of plant tissues and organs. They may serve various protective, strengthening and other functions. For example sclereids may form bands around seeds or cover roots or stems, possibly for strengthening purpose [1]. Individual sclereids called (idioblast) may cause tissues to be gritty and coarse and less palatable to insects [2]. Such sclereids are frequently observed in the mesophyll of leaves of many plant genera, e.g. Borina [3] Nymphaea [4,5] and others [6]. The formation of sclereids can be observed during normal development of tissues and organs. Various type of sclereids are found among different species and rarely in aquatic species [7, 8]. They are however found in the stem and fruits of all the species examined. The present paper deals with the sclereid of 26 genera under 15 different families which is found from the pulp and outer portion of the ripening fruit leaf and stem. Here, we also observed that type and structure of sclereid under phase contrast microscope (PCM).

MATERIALS AND METHODS

Plant materials are not found in a particular place. Majority of materials were collected from Paschim and Purba Medinipur, district of West Bengal and rest of the Materials are collected from other places from India.

Sclereid isolation and Purification

The collected material were crushed with motor passel and taken in different slides with the help of brush. Permanent slides are prepared with glycerin. The slide were observed under Light Microscope

(10X x 40X) [Olympus], Phase Contrast Microscope (Leica DM-1000) obtaining better picture as well as measuring the length and breadth of sclereid.

Table: 1 Plant Name, Family, General morphology, Place of collection, flowering & fruiting period and type of sclereid of some selected taxa

Name of Plant	Family	General morphology	Place of collection	Flowering and Fruiting period
1.*Annona reticulata* Linn.	Annonaceae	Small tree,leaves oblong-lanceolate,acute-acuminate, glabrous. Fruit sub-globose, pentagonal, Yellowish-brown.	Darua, Purba Medinipore.	May-January
2.*Luffa acutangula* Cav.	Cucurbitaceae	Climbers, leaves cordate, usually 5 angled.tendrils 2-5 fid. Flowers yellow. Fruit clavate.	Medinipore	March-September
3.*Trichosanthes dioica* Roxb.	Cucurbitaceae	Herbaceous climbers, leaves cordate oblong. Fruit a lanceolate or globose.	Medinipore	February-September
4.*Diospyros kaki* Linn.	Ebenaceae	Trees, leaves alternate, flower dioecious, rarely polygamous. Fruit a globose, ellipsoid.	Darua, Purba Medinipore.	January- August.
5. *Jatropha gossypifolium* Linn.	Euphorbiaceae	Shrubs often glandular or prickly. Leaves alternate. Flowers monoecious in terminal cymes. Fruit a capsule of 2-4.	Vidyasagar University campus.	March- October.
6. *Putranjiva roxburghii* wall.	Euphorbiaceae	Trees, leaves evergreen, entire or serrulate.Flowers axillary. Fruit an ovoid globose drupe.	Rajbhawan, Kolkata	March-October
7. *Cinnamomum tamala* Nees & Ebern.	Lauraceae	Evergreen trees, leaves opposite. Flowers small hermaphrodite. Fruit a berry	Rabindra Nagar. Paschim Medinipore.	March-September
9. *Cinnamomum zeylanicum* Blume.	Lauraceae	Evergreen tree or shrubs. Leaves opposite. Flowers small, axillary. Fruit a berry.	Purba Medinipore.	March- September.
10. Michelia champaca Linn.	Magnoliaceae	Trees or shrubs, deciduous an evergreen tree. Leaves alternate, simple stipule convulate. Flowers bisexual actinomorphic. Fruit globose.	Vidyasagar University campus	March- October.
11. *Ficus benghalensis* Linn.	Moraceae	Trees or shrubs, sometimes scandent, juicy milky leaves obtuse. Fruit an enlarged, hollow, cup shape closed receptacle, fleshy schmes.	Vidyasagar University Campus.	February-May
12. *Ficus carica* Linn.	Moraceae	Trees juice milky, leaves alternate, rarely opposite,entire,lobed, serrate or toothed. Flowers minute. Fruit an enlarged, hollow cup-shaped.	Tatigeria, Paschim Medinipore.	March- September
13. *Ficus religiosa*	Moraceae	Trees leaves 5-7 nerved at the base broadly ovate. Flowers minute. Fruit an enlarged, hollow, cup shaped.	Vidyasagar University campus	March- September.
14. *Moringa oleifera* Lamk.	Moringaceae	Trees, with soft white wood and with gummy juice, leaves alternate, compound. Flower	Paschim Medinipore.	February_ -May.

		irregular. Fruit one celled loculicidally 3 valved capsule.		
15. *Psidium guajava* Linn.	Myrtaceae	Trees or shrub. Leaves opposite. Flowers large white, axillary, fruit a globose ovoid or berry	Vidyasagar University Campus	June - October
16. *Olea europaea* Linn.	Oleaceae	Evergreen tree, leaves are oblong in shape, small white flowers.	Paschim Medinipur.	July- January.
17. *Nelumbo nucifera* Gaerth.	Nymphaeaceae	Shrub. Leaves are shiny, roundish. Flowers are big, single white to pink in colour.	Vidyasagar University Campus.	January_November.
18. *Nymphaea nouchali* Burn. f.	Nympheaceae	Sub- merged plant. Part of the leaves are sub- merged. The leaves are round and green on top. Flower is usually violet in colour with redish edges.	Paschim Medinipur.	August- January.
19. *Nymphoides cristata* (Roxb) Kuntze.	Menyanthaceae	Aquatic herb. Leaves broadly ovate elliptic or reniform to orbicular. Flowers white, sepals usually ovate lanceolate. Fruit a spongy, berry ripping under water.	Purba Medinipur.	July- January.
20. *Pisum sativum* Linn.	Fabaceae	Herbs diffuse or climbing. Leaves even pinnate. Flowers axillary peduncled, showy solitarian in few fid racems. Fruit an obliquely pointe or submerged pod.	Paschim Medinipore.	November- January.
21. *Fragaria vesca* Linn.	Rosaceae	Shrubs. Leaves digitately 3 foliate, rarely 5 foliate. Flower white or yellow often polygamous many, fruit large.	Nainital	January- September
22. *Malus sylvestris* Linn.	Rosaceae	Tree or shrub,deciduous or semigreen. leaves alternate. Flower pedicillate, racemose, petal 5 white, pink or red.	Midnapore	March_ November.
23. *Pyrus communis* Linn.	Rosaceae	Trees or shrubs, deciduous, rarely semi- evergreen. Leaves alternate, stipulate. Flowers precocious or synantherous.	Midnapore	March- June.
24. *Madhuca Indica* Linn.	Sapotaceae	Trees, milky sap present in laticiferous ducts or sac in their vegetative parts. Leaves simple alternate. Fruit often berry.	Paschim Medinipore	March- September.
25. *Mimusops elengi* Linn.	Sapotaceae	Trees. Leaves elliptic or obovate. Flower axillary. Fruit a globose, berry .	Vidyasagar University Campus	January- June.
26. *Manilkara achras* Linn.	Sapotaceae	Evergreen trees. Leaves simple petiolate. Flowers rather large, brownish white, fragrant light, solitary or axillary. Fruits berry.	Kolkata	March- December.

Table: 2 -Sclereids distribution and size in stems of some selected taxa.

Name of the Plant	Sclereid count		Sclereid Measurement				Total Cell Count (TC)	% Different type of sclereids	Sclereid Index (SI) S.I.= S/ S+TC
	(Cm2)		μm						
	Cortex region	Pith region	Cortex region		Pith region				
			Length	Breadth	Length	Breadth			
Cinnamomum tamala Nees & Eberm	25	-	64.73	37.49	-	-	62	Same	0.28
Cinnamum zeylanica Blume	19	-	60.8	38.49	-	-	54	Same	0.26

Table: 3 -Sclereids distribution and size in leaves

Name of the Plant	Sclereid count		Sclereid Measurement				Total cell count	% different type of sclereids	Sclereid Index (SI) S.I. = S/ S+TC
	cm^2		μm						
	Adaxial surface	Abaxial surface	Adaxial surface		Abaxial surface				
			Length	Breadth	Length	Breadth			
Nelumbo nucifera Gaenth	30	-	30.31	28.09	-	-	72	Same	0.29
Nymphaea nouchali Burm.f.	27	-	302.15	25.99	-	-	74	Same	0.26
Nymphoides cristata (Roxb) Kuntze	26	-	148.34	27.59	-	-	85	Same	0.23
Olea europaea Linn.	18	-	593.93	18.23	-	-	36	Same	0.33

Table: 4 Sclereids distribution and Size in fruits of some selected taxa.

Name of the Plant	Sclereid count		Sclereid Measurement				Total cell count	% different type of sclereid	Sclereid Index (SI) S.I.= S/S+TC
	(cm^2)		μm						
	Exocarp	Mesocarp	Exocarp		Mesocarp				
			Length	Breadth	Length	Breadth			
Annona reticulata Linn	22	16	65.16	43.51	63.23	41.52	111	Same	0.25
Luffa acutangyla Cav.	18	-	26.88	10.25	-	-	62	Same	0.22
Momordica charantia Linn.	2	1	744.04	26.81	712.48	24.84	26	Same	0.09
Trichosanthes dioica Roxb.	12	28	23.39	16.45	-	-	106	Same	0.3
Diospyros kaki Linn.	35	5	125.66	60.82	111.88	74.34	106	Same	0.27
Jatropha gossypifolia Linn.	6	8	69.81	64.61	64.81	61.24	48	Same	0.22
Putranjiva roxburghi Wall.	53	48	31,04	29.42	29.7	23.93	115	Same	0.46
Michelia champaca Linn.	1	1	-	-	935.95	20.48	12	Same	0.07
Ficus	9	8	62.12	42.34	60.77	43.62	50	Same	0.25

benghalensis Linn.									
Ficus carica Linn.	3	2	954.17	19.57	916.71	20.83	62	Same	0.07
Ficus religiosa Linn.	4	6	37.77	38.97	38.12	29.66	33	Same	0.23
Moringa oleifera Lamk.	18	-	92.33	47.81	-	-	68	same	0.2
Psidium guajava Linn.	-	39	-	-	61.08	47	110	same	0.26
Pisum sativum Linn.	-	115	-	-	16.32	16.3	86	Same	0.57
Frageria vesca Linn.	-	3	-	-	1017.16	24.56	12	Same	0.2
Malus sylvestris Linn.	-	2	-	-	806.6	25.62	38	same	0.05
Pyrus communis Linn.	-	65	-	-	77.34	60.61	148	Same	0.305
Madhuca indica Linn.	-	19	-	-	36.61	82.48	28	Same	0.208
Mimusops elengi Linn.	-	19	-	-	36.61	82.48	72	Same	0.208
Manilkara achras Linn.	-	16	-	-	138.6	76.17	52	same	0.235

Table: 5. Present of Five Types of Sclereids In selected Plant Taxa

Name of the Plant	**Name of the Family**	**Types of Sclereids**				
		Brachy sclereid	Macro Sclereid	Astro Sclereid	Osteo sclereid	Tricho Sclereid
Annona reticulata Linn.	Annonaceae	+	-	-	-	-
Cinnamomum tamala Nees & Eberm.	Lauraceae	+	-	-	-	-
Cinnamomum zeylanica Blume.	Lauracea	+	-	-	-	-
Diospyros kaki Linn.	Ebenaceae	+	-	-	-	-
Ficus benghalensis Linn.	Moraceae	+	-	-	-	-
Ficus carica Linn.	Moraceae	+	+	-	-	-
Ficus religiosa Linn.	Moraceae	-	-	-	-	-
Frageria vesca Linn.	Moraceae	+	+	-	-	-
Jatropha gossypifolium Linn.	Euphorbiaceae	-	-	-	-	-
Luffa acutangula Cav.	Cucurbitaceae	+	-	-	-	-
Madhuca indica Linn.	Sapotaceae	+	+	-	-	-
Malus sylvestri Linn.s	Sapotaceae	-	+	-	-	-
Manilkara achras linn.	Sapotaceae	-	-	-	-	-
Michelia champaca Linn.	Magnoliaceae	-	+	-	-	-
Mimusops elengi Linn.	Sapotaceae	+	-	-	-	-
Momordica charantia Linn.	Cucurbitaceae	-	+	-	-	-
Moringa oleifera Lamk.	Moringaceae	+	-	-	-	-
Nelumbo nucifera Gaenath	Nymphaeaceae	-	-	+	+	-
Nymphaea nouchali Burm. f.	Nymphaeaceaae	-	-	-	-	-
Nymphoides cristata (Roxb) Kuntze	Nymphaeaceae	-	-	+	+	+
Olea europaea Linn.	Nyctanthaceae	-	-	-	-	-
Pisum sativum Linn.	Papilionaceae	-	+	-	-	-
Psidium guajava Linn.	Myrtaceae	+	-	-	-	-
Putranjiva roxburghi Wall.	Euphorbiaceae	+	-	-	-	-

Pyrus communis Linn.	Rosaceae	+	-	-	-	-
Trichosanthes dioica Roxb.	Cucurbitaceae	+	-	-	-	-

' +' Indicate present of sclereids; '-' Indicate absent of sclereids

Table: 6 Medicinal uses of some selected taxa

SL. No.	Name of the plant	Family	Medicinal uses
1.	*Cinnamomum tamala* Nees& Eberm.	Lauraceae	**Leaves:** used as stimulant, to treat aphomia, ringworm, rheumatism. **Bark:** used in gonorrhoea.
2.	*Cinnamomum zeylanicum* Bume.	Lauraceae	**Bark:** used as astringrnt, carminative, used to cure weakness of the stomach, diarrhoea, nausea, vomiting heart disease, bronchitis, tumours piles, dyspepsia.
3.	*Ficus benghalensis* Linn.	Moraceae	**Latex** is used as an anthelmintic.
4.	*Jatropha gossypifolia* Linn.	Euphorbiaceae	**Leaves:** used in eczema. **Roots:** used in leprosy & snake bites.
5.	*Manilkara achras* Linn.	Sapotaceae	**Chicle gum**: used in dental surgery.
6.	*Mimusops elengi* Linn.	Sapotaceae	**Seeds & dried fruits**: highly effective in curing piles.
7.	*Madhuca indica* Linn.	Sapotaceae	**Seeds:** oil from seeds is effective in skin diseases &rheumatism.
8.	*Michelia champaca* Linn.	Magnoliaceae	**Flowers & Fruits**: used to cure kidney troubles & gonorrhoea.
9.	*Nymphaea nouchali* Burm. f.	Nymphaeaceae	**Rhizomes:** used to cure dysentery& diarrhoea.
10.	*Nelumbo nucifera* Gearth.	Nymphaeaceae	**Rhizomes:** to cure piles. **Leaves**: used in curing diseases of liver.
11.	*Pyrus communis* Linn.	Rosaceae	**Bark:** Dried bark is used in cough & cold.
12.	*Psidium guajava* Linn.	Myrtaceae	**Leaves:** used in dental problem.

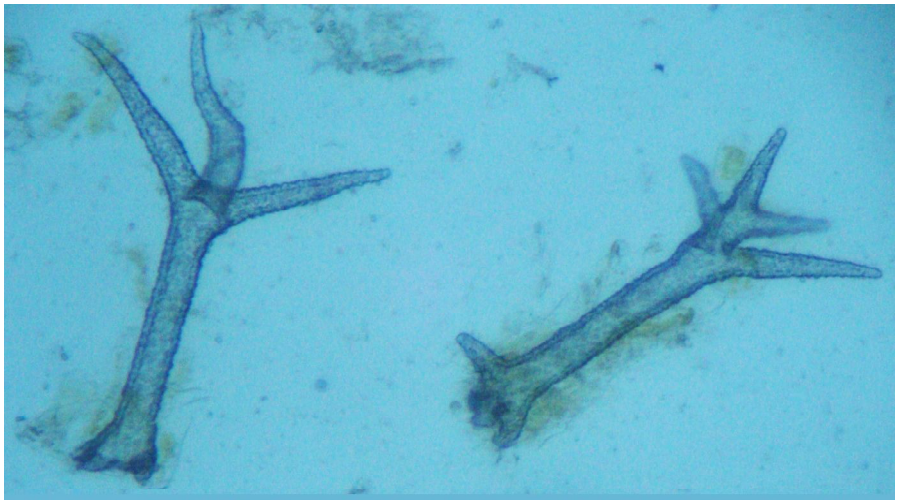

Fig:1 Osteo sclereid of *Nymphaea nouchali* from adaxial surface of leaf

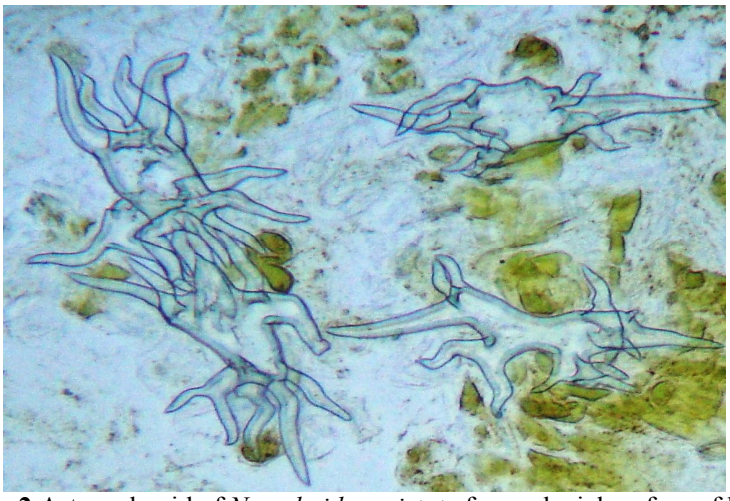

Fig: 2 Astro sclereid of *Nymphoides cristata* from adaxial surface of lea.

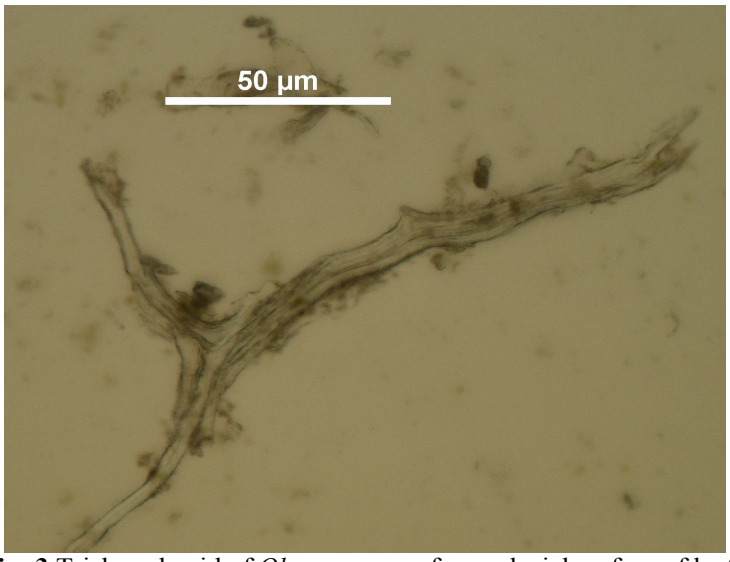

Fig: 3 Tricho sclereid of *Olea europoea* from adaxial surface of leaf..

Fig:4 Brachy sclereid of *Cinnamoum zeylanicum* from cortex region.

Fig: 5 Brachy sclereid of *Cinnamomum tamala* from cortex region.

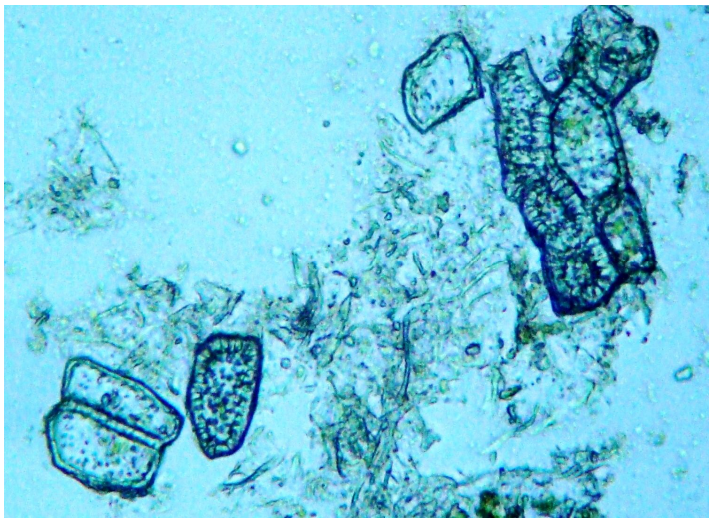

Fig: 6 Brachy sclereid of *Moringa oleifera* from exocarp portion..

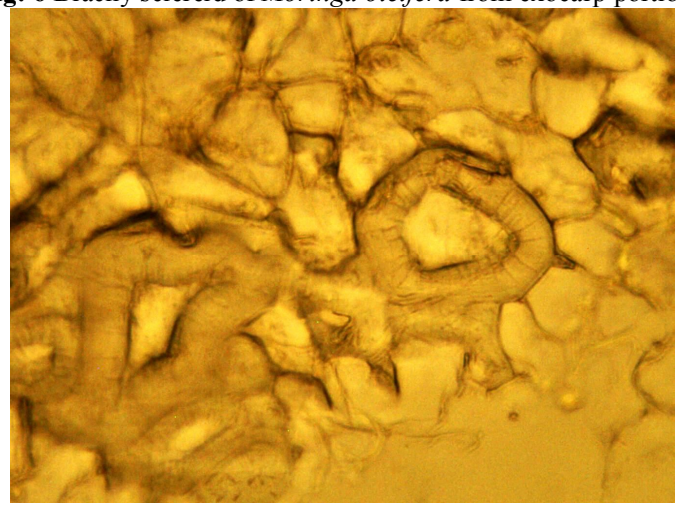

Fig: 7 Brachy sclereid of *Psidium guajava* from pulp portion.

Fig: 8 Macro sclereid of *Malus sylvestris* from exocarp portion.

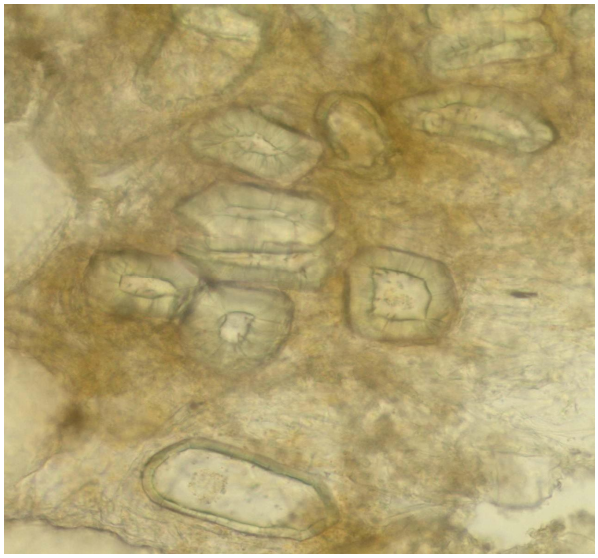

Fig: 9 Brachy sclereid of *Manilkara achras* from exocarp portion.

Fig: 10 Brachy sclereid of *Mimusops elengi* from pulp portion.

DISCUSSION

Sclereids are generally initiated in fundamental parenchyma [2]. In *Camellia,* a terrestrial plant, the foliar sclereids originate and develop simultaneously [9]. However, in tissues of laminae in floating leaves of aquatic spices like *Nymphaea nouchali* (Fig:1)[4,5,7] and *Nymphoides cristatum*, (Fig:2)*Nelumbo nucifera* , different differentiation pattern. It is interesting that, though these 3 genera belong to the same family Nymphaeaceae they shows different shaped sclereids.(Table:3) In *Olea europaea*(Fig:3) Under the family Nyctanthaceae trichosclereid is found. The length is 593.93µm in *Olea eufopaea* and breadth is 18.23µm. Whereas in *Nelumbo nucifera* the length is 30.31µm and breadth is 28.09µm.

Sclereids found from stem in *Cinnamomum zeylanicum*, *Cinnamomum tamala* under the family Lauraceae. Here a typical structure is found. Both contain same type of sclereids, that is brachy sclereids but structurally they are different. In *Cinnamomum zeylanicum*(Fig:4) sclereids are half pitted an pits are small in size and lumen is very thin , gap is present in between lumen. In *Cinnamomum tamala* (Fig:5)sclereids are full pitted and pits are small in size, lumen is thin and closely present. The length is 64.73µm and breadth is 37.49µm in *cinnamomum tamala*. In cinnamomum zeylanicum the length and breadth are 60.8µmand 38.49µm respectively.(Table:2).

Sclereids are found from some vegetable fruit like *Momordica charantia*, *Luffa acutangula*, *Trichosanthes dioica* under the family Cucurbitaceae , *Artocarpous heterophyllus* , *Ficus benghalensis* , *Ficus carica* under the family Moraceae and *Moringa oleifera* (Fig:6) under the family Moringaceae Majority of the above taxa having brachy type of sclereids but some differentiation was found. Morphological differentiation and distribution pattern shoot remarkable variation (Table:4)

Sclereids are found from some edible fruits like *Psidium guajava* (Fig:7) under the family Myrtaceae, *Malus sylvestris*, (Fig:8) *Pyrus communis*, *Frageria vesca* under the family Rosaceae, *Manilkara achras*,(Fig:9) *Mimusops* elengi (Fig:10) *Madhuca indica* under the family Sapotaceae contained brachy type of sclereids but some differentiation were also observed. The distribution and structure are different. The large length of sclereid in *Frageria vesca* is 1017.16µm. The small breadth of sclereid in Pisum sativum is 16.3µm.

CONCLUSION

Obviously the different morphology of brachy sclereids among the selected taxa have taxonomical significance. However, not only the ecological function but also similar value in evolutionary implications. Different types of sclereids which are found in different plant organ within different species and sclereids which are different tissue with in and organs might be used for taxonomic problem [10]. The different from of may be characteristic of a particulars species and thus of taxonomic value. Various type of sclereids are found among different species, and sclereids in different tissues and organs have been used for plant classification [10, 11].

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