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ANATOMICAL STUDIES OF SOME MEDICINAL PLANTS OF FAMILY POLYGONACEAE

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Abstract

Anatomical studies of the 6 different species of family Polygonaceae viz., *Rumex hastatus* D. Don, *Rumex dentatus* Linn, *Rumex nepalensis* Spreng, *Rheum australe* D. Don, *Polygonum plebejum* R. Br and *Persicaria maculosa* S.F. Gay are presented. The study is based on the presence and absence of epidermis, parenchyma, collenchyma, sclerenchyma, endodermis, pericycle, xylem, phloem, pith, mesophyll cells and stone cells.

Introduction

The medicinal plants have been used by Hakims and in folklore medicines as 80% of the population lives in rural areas that mostly depend on Unani system of medicines (Soomro *et al*., 1997). The available literature shows that leaf epidermal features are important in systematic botany similar to the use of modern techniques and chemical composition (Edeoga & Ikem, 2001; Mbagwu & Edeoga, 2006). Epidermal structures and stomatal ontogeny of some Nigerian ferns have been found relevant in their recognition (Gill & Karatela, 1985). Olowokwudejo (1990) compared the morphology of the leaf epidermis in *Annona* and suggested the utilization of this character in the identification of the species. Many workers such as Edeoga (1991), Edeoga & Osawe (1996), Mbagwu & Edeoga (2006), Nwachukwu & Mbagwu (2006) stressed that epidermal and cuticular traits of plants epidermal cells, type and arrangement of stomata, size and shape of trichomes and number of vascular bundles could serve as vital tools in solving taxonomic problems in Angiosperms. Budel *et al*., (2007) reported chlorenchyma, sclerenchyma, vascular system and cells in *Homalocladium platycladum*. Yasmin *et al*., (2009) reported that epidermal cell shapes are variable but generally polygonal among the *Aconogonon* and *Bistorta*. Ayodele & Olowokudejo (2006) made comparative studies on the leaf epidermal features of different species of Family Polygonaeae and reported variation in various characters among species. Zhao *et al*., (2006) observed alterations in leaf trichomes, stomatal characteristics and epidermal cellular features of rhubarb (*Rheum rhaponticum* L.). As no such information is available on the anatomy of these 6 species of Polygonaceae therefore the present study was conducted to see the various anatomical features. The study would help in the identification and authentification of these medicinal plants on the basis of anatomy.

Materials and Methods

Fresh specimens of *Rumex hastatus* D. Don, *Rumex dentatus* Lin, *Rumex nepalensis* Spreng, *Persicaria maculosa* S.F. Gay and *Polygonum plebejum* R.Br were collected from University of Peshawar and *Rheum australe* D. Don from Gram Chashma (Chitral)

during March-November 2005. They were identified with the help of Flora of Pakistan (Ali & Qaiser, 2007). Free hand thin transverse sections were made from fresh materials and stained. Ten readings were taken by micrometer and minimum, maximum, mean and frequent values were determined by standard method following Puruis *et al*., (1966).

Results and Discussion

a. Roots: Epidermis in roots of *R. hastatus*, *R. nepalensis*, *R. australe* and *P. maculosa* was single layered. It was two layered in *R. dentatus* and *P. plebejum*. Length of the epidermal cells was maximum in *R. hastatus* and minimum in *P. maculosa*. Width of the epidermal cells was maximum in *R. dentatus* and minimum in *P. plebejum*. Khan *et al*., (2001) reported epidermal tissue, collenchyma and thicked walled parenchyma cells in *Asplenium dalhousiae*. The many layered parenchyma compactly packed in all the 6 species. It was polygonal shape in *R. nepalensis*, *R. australe* and *P. maculosa* and spherical in *R. dentatus, P. plebejum* and *R. hastatus*. Length of the parenchyma was maximum in *R. hastatus* and minimum in *P. maculosa*. Width of the parenchyma was maximum in *R. hastatus* and minimum in *P. maculosa*. Kanwal *et al*., (2006) reported similar study for epidermis, parenchyma, cortex, parenchymatous pith and xylem in *Pongamia pinnata.* Collenchyma was present in *P. maculosa* and *P. plebejum* but was absent in other species. It was spherical in both species. Mean length and width of the collenchyma in *P. plebejum* and *P. maculosa* was 78.5µ; 34.4µ and 27.3µ and 15.7µ, respectively. Sclerenchyma was present in *R. hastatus* and *R. australe* and was absent in other species. It was polygonal in *R. hastatus* and spherical in *R. australe*. These cells were few in number. Mean length and width of the cells in *R. hastatus* and *R. australe* was 149µ; 62.5µ and 107.5µ and 27.7µ, respectively. Endodermis was a single layered in *R. hastatus*, *R. nepalensis*, *R. australe* and *P. plebejum*. It was two layered in *R. dentatus* and *P. maculosa*. The cells were elongated in *R. hastatus* and *P. plebejum*; oval in *R. dentatus*, *R. nepalensis* and spherical in *R. australe* and *P. maculosa*. Length of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Width of the cells was maximum in *R. hastatus* and was minimum in *P. maculosa*. Pericycle was a single layered in *R. dentatus*, *R. nepalensis* having spherical, in *R. australe* and *P. plebejum* oval. It is absent in *R. hastatus* and *P. maculosa*. Length of the cell was maximum in *R. nepalensis* and minimum in *R. australe*. Width of the cell was maximum in *R. nepalensis* and minimum in *P. maculosa*. Xylem was oval in shape except *P. plebejum* in which it was spherical in shape. Length of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Width of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Phloem was elongated in *R. hastatus*; oval in *R. dentatus* and *P. plebejum* and spherical in *R. nepalensis*, *R. australe*, *P. maculosa*. Length of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Width of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Pith was absent in *R. hastatus*, *P. maculosa* and *P. plebejum.* It was spherical in *R. dentatus*, *R. nepalensis* and *R. australe.* Mean length and width of the cell in *R. dentatus, R. nepalensis* and *R. australe* was 94.5µ, 34.2µ and 83.5µ and 85.2µ, 17.7µ and 38.2µ, respectively. Stone cell was only present in *P. plebejum* and was absent in other plant species (Table 1).

b. Stem: Epidermis in stem of *R. hastatus*, *R. dentatus*, *R. nepalensis*, *R. australe* and *P. maculosa* was single layered and two layered in *P. plebejum*. The cells were spherical in *R. hastatus*, oval in *R. dentatus, R. nepalensis*, *R. australe* and *P. maculosa* and elongated in *P. plebejum*. Length of the cell was maximum in *R. dentatus* and minimum in *P. maculosa*. Width of the cell was maximum in *R. nepalensis* and minimum in *P. maculosa*. The many layered parenchyma was compactly packed in all species. It was polygonal in *R. hastatus, R. australe, R. dentatus* and *P. maculosa* and oval in *R. nepalensis* and *P. plebejum*. Length of the cell was maximum in *R. hastatus* and minimum in *R. nepalensis*. Width of the cell was maximum in *R. hastatus* and minimum in *P. maculosa*. Saeed & Khan (1996) reported parenchyma and epidermis in *Sonchus asper*. Collenchyma was present only in *R. hastatus* and *R. dentatus* and *R. nepalensis*. It was spherical in shape. Mean length and width of the cell in *R. hastatus*, *R. dentatus* and *R. nepalensis* was 128.5µ, 115.5µ and 129µ and 74.5µ, 39.8µ and 68.2µ, respectively. Sclerenchyma was present only in *R. australe, P. maculosa* and *P. plebejum.* It was spherical in shape. Mean lengths of the cells in *R. australe*, *P. plebejum* and *P. maculosa* was 106µ, 136.4µ and 97µ and mean widths of the cells were 44.7µ, 64µ and 55.4µ, respectively. Single layered endosperm is present in *R. hastatus, R. dentatus*, *R. nepalensis*, *P. maculosa* and *P. plebejum* and was absent in *R. australe*. The cells were elongated in *P. plebejum* and oval in *R. dentatus*, *R. nepalensis* and *R. hastatus*. Pericycle was a single layered in all six specimens and was spherical in *R. nepalensis*, *R. australe* and *P. maculosa* and oval in *R. hastatus*, *R. dentatus* and *P. plebejum*. Length of the cell was maximum in *R. hastatus* and minimum in *P. plebejum*. Width of the cell was maximum in *R. nepalensis* and minimum in *P. plebejum*. Xylem was oval except *P. plebejum* in which it was spherical. Length of the cell was maximum in *R. hastatus* and minimum in *P. plebejum*. Width of the cell was maximum in *P. maculosa* and minimum in *P. plebejum*. Phloem was elongated in *R. hastatus*, *R. dentatus* and *P. plebejum* and spherical in *R. nepalensis*, *R. australe*, *P. maculosa*. Length of the cell was maximum in *R. hastatus* and minimum in *R. dentatus*. Width of the cell was maximum in *R. australe* and minimum in *P. maculosa*. Pith was absent in *R. hastatus* and *R. dentatus.* It was spherical in *R. nepalensis*, *R. australe, P. maculosa* and *P. plebejum.* Mean length and width of the cell in *R. nepalensis*, *R. australe, P. maculosa* and *P. plebejum* was 52.1µ, 89µ, 70.7µ and 45µ and 16.9µ, 36.2µ, 28.4µ and 12.3µ, respectively. Stone cell was only present in *P. plebejum* and was absent in other stems (Table 2). Metcalfe & Chalk (1957) reported stone cells in *P. plebejum,* which agree with the present study.

c. Petiole: Petiole was absent in *P. plebejum.* Epidermis in stem of *R. hastatus* was two layered and single layered in *R. dentatus, R. nepalensis*, *R. australe* and *P. maculosa*. The cells were oval. Length of the cell was maximum in *P. maculosa* and minimum in *R. dentatus*. Width of the cell was maximum in *R. nepalensis* and minimum in *R. hastatus*. Parenchyma in all species was compactly packed. It was polygonal in *R. hastatus, R. dentatus, R. australe* and *P. maculosa* and spherical in *R. nepalensis*. Length of the cell was maximum in *R. australe* and minimum in *R. hastatus*. Width of the cell was maximum in *R. australe* and minimum in *R. hastatus*. Collenchyma was present in *R. hastatus* and *R. dentatus*, *R. nepalensis* and was absent in *P. maculosa* and *R. australe.* It was spherical in shape. Mean length and width of the cell in *R. hastatus*, *R. dentatus* and *R. nepalensis* was 27.7µ, 23.7µ and 50.1µ and 11.7µ, 11.3 µ and 23.9µ,

respectively. Sclerenchyma was present in only *R. australe* and *P. maculosa*. Endodermis was two layered in *R. hastatus* and was single layered in *R. dentatus*, *R. nepalensis* and *P. maculosa.* The cells were oval in *R. dentatus*, *R. nepalensis* and *R. hastatus* and spherical in *P. maculosa.* It was absent in *R. australe*. Pericycle was a single layered in all specimens and was spherical in *R. nepalensis*, *R. hastatus* and *P. maculosa* and oval in shape in *R. australe* and *R. dentatus*. Length of the cell was maximum in *P. maculosa* and minimum in *R. dentatus*. Width of the cell was maximum in *R. australe* and minimum in *R. dentatus*. Xylem was oval in shape except *R. australe* in which it was spherical. Length of the cell was maximum in *P. maculosa* and minimum in *R. hastatus*. Width of the cell was maximum in *R. hastatus* and minimum in *R. nepalensis*. Phloem was spherical in *R. hastatus*, *R. dentatus* and *R. nepalensis* and *P. maculosa* and oval in *R. australe.* Length of the cell was maximum in *R. australe* and minimum in *R. hastatus*. Width of the cell was maximum in *R. australe* and minimum in *R. hastatus*. Pith was absent in *R. dentatus* and *R. hastatus*. It was spherical in shape in *R. nepalensis*, *P. persicaria* and *R. nepalensis*.

d. Leaf: In leaves epidermis was single layered in all six leaves. The cells were spherical in *R. nepalensis* and *P. maculosa* and elongated in *R. hastatus*, *R. dentatus*, *R. australe* and *P. plebejum.* Length of the cell was maximum in *R. dentatus* and minimum in *R. hastatus*. Width of the cell was maximum in *R. dentatus* and minimum in *R. hastatus*. Mesophyll was elongated. Length of the cell was maximum in *P. plebejum* and minimum in *P. maculosa*. Width of the cell was maximum in *R. australe* and minimum in *R. dentatus*. Pereira *et al*., (1997) reported that the leaflet blade consisted of the unicellular upper epidermis and lower epidermis-enclosing palisade and spongy mesophyll in *Pueraria phaseoloides*. Collenchyma was present only in *R. hastatus* and *P. plebejum*. Sclerenchyma was present only in *R. australe*, *P. plebejum* and *P. maculosa* and was oval in shape. Endodermis was single layered in *R. hastatus*, *R. dentatus*, *R. nepalensis* and *P. maculosa.* It was absent in *R. australe* and *P. plebejum*. Pericycle was oval and single layered in *R. hastatus*, *R. dentatus*, *R. nepalensis*, *R. australe* and *P. maculosa*. It was absent in *P. plebejum*. Xylem was oval in *R. hastatus*, *R. nepalensis* and *P. maculosa* and spherical in *R. dentatus*, *R. australe* and *P. plebejum*. Length of the cell was maximum in *R. hastatus* and minimum in *R. australe*. Width of the cell was maximum in *R. nepalensis* and minimum in *R. australe*. Phloem was spherical in *R. hastatus*, *R. nepalensis*, *P. maculosa* and oval in *R. dentatus*, *R. australe* and *P. plebejum*. Length of the cell was maximum in *R. dentatus* and minimum in *R. australe*. Width of the cell was maximum in *R. nepalensis* and minimum in *R. australe*. Pith was absent from *R. hastatus* and *R. nepalensis* and was present *R. dentatus, R. australe, P. maculosa* and *P. plebejum.* Mean length and width of the cell in *R. dentatus*, *R. australe, P. maculosa* and *P. plebejum* were 41.5µ, 53.3µ, 49.2µ and 59.5µ and 22.3µ, 17.1µ, 20.7µ and 14.3µ, respectively. Metcalfe & Chalk (1957) reported the stem and leaf anatomy of the family Polygonaceae.

Table 1. Microscopical measurement (µm) of the roots of the various species of Polygonaceae.

Plant parts		*Rumex hastatus*		*Rumex dentatus*		*Rumex nepalensis*		*Rheum australe*		*Persicaria maculosa*		*Polygonum plebejum*	
		L	W	L	W	L	W	L	W	L	W	L	W
Epidermis	m	95	55	77	60	60	30	60	20	57	21	15	6
	M	130	85	115	101	95	60	99	45	80	38	60	28
	*	115	60	93	76	75	35	75	25	60	26	32	15
	**	125.5	69	92.5	77.6	76	41	77.4	29.3	64.4	27.7	35	14
Parenchyma	m	145	115	43	33	70	50	40	10	18	6	40	17
	M	175	140	94	85	115	75	60	25	45	16	60	36
	*	160	125	75	67	95	60	45	15	25	12	51	22
	**	163.5	129.5	70.2	62	94.5	60.5	47.2	15.3	25.8	11.5	52.3	25.2
Collenchyma	m	-	-	-	-	-	-	-	-	20	10	65	19
	M	-	-	-	-	-	-	-	-	49	22	100	45
	*	-	-	-	-	-	-	-	-	35	15	75	21
	**	-	-	-	-	-	-	-	-	34.4	15.7	78.5	27.3
Sclerenchyma	m	135	90	-	-	-	-	50	20	-	-	-	-
	M	160	120	-	-	-	-	90	40	-	-	-	-
	*	145	110	-	-	-	-	55	25	-	-	-	-
	**	149	107.5	-	-	-	-	62.5	27.7	-	-	-	-
Endodermis	m	110	60	39	25	55	22	25	12	22	8	85	33
	M	130	85	103	70	63.5	40	50	25	37	15	100	55
	*	115	70	63	30	75	33	33	17	31	11	93	42
	**	120	72.5	71.3	45.9	63.5	33.2	35.4	17.7	30.6	11.3	92.3	43.1
Pericycle	m	-	-	40	30	70	35	35	17	35	12	45	17
	M	-	-	89	70	100	60	55	25	57	25	65	30
	*	-	-	49	37	80	45	40	19	43	19	57	21
	**	-	-	64.7	46	80	47.5	41.9	19.7	43.7	19.8	56.9	22
Xylem	m	185	125	80	60	65	25	39	18	17	9	49	17
	M	210	170	113	101	85	55	55	25	55	21	85	43
	*	200	140	95	82	71	37	44	22	32	18	69	31
	**	199	141.5	95.8	81.3	71.7	39.4	45.6	21.9	31.7	16.5	67.8	30.2
Phloem	m	160	125	41	30	35	9	45	25	19	7	60	21
	M	185	140	80	68	65	30	85	49	57	17	105	41
	*	178	135	59	52	42	22	55	32	35	15	88	26
	**	174.2	133	58.4	51.3	43.9	20	60	35.7	37	13.4	88.3	28.3
Pith	m	-	-	80	75	25	15	60	30	-	-	-	-
	M	-	-	115	100	40	25	105	60	-	-	-	-
	*	-	-	88	79	35	18	85	35	-	-	-	-
	**	-	-	94.5	85.2	34.2	17.7	83.5	38.2	-	-	-	-
Stone cell	m	-	-	-	-	-	-	-	-	-	-	55	21
	M	-	-	-	-	-	-	-	-	-	-	75	45
	*	-	-	-	-	-	-	-	-	-	-	59	33
	**	-	-	-	-	-	-	-	-	-	-	60.9	33.9

Table 2. Microscopical measurement (µm) of the stems of the various species of Polygonaceae.

Plant parts		*Rumex hastatus*		*Rumex dentatus*		*Rumex nepalensis*		*Rheum australe*		*Persicaria maculosa*		*Polygonum plebejum*	
		L	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Epidermis	m	95	40	115	38	70	55	50	20	40	18	73	35
	M	125	65	160	75	115	70	85	45	80	35	97	60
	*	115	50	125	55	90	60	65	28	55	23	85	45
	**	114.5	51	130.9	54.8	91	62.2	67.5	31	58.5	23.5	86.9	48
Parenchyma	m	140	60	40	35	40	22	70	29	60	15	90	40
	M	165	95	90	70	70	33	95	40	95	38	117	70
	*	145	80	75	55	55	25	88	36	80	19	110	55
	**	150.4	79	71	56.4	57	27.9	83.7	34.7	80.5	23.7	100.9	54.5
Collenchyma	m	120	55	90	30	90	55	-	-	-	-	-	-
	M	145	90	150	50	150	87	-	-	-	-	-	-
	*	125	75	115	45	135	66	-	-	-	-	-	-
	**	128.5	74.5	115.5	39.8	129	68.2	-	-	-	-	-	-
Sclerenchyma	m	-	-	-	-	-	-	70	37	80	48	110	50
	M	-	-	-	-	-	-	125	58	115	63	150	85
	*	-	-	-	-	-	-	113	48	95	53	42	60
	**	-	-	-	-	-	-	106	44.7	97	55.4	136.4	64
Endodermis	m	90	18	50	27	40	20	-	-	80	17	45	17
	M	120	42	75	38	70	40	-	-	110	37	75	38
	*	115	22	55	30	55	22	-	-	95	21	61	31
	**	111.5	27.6	60.5	32.6	59	28.7	-	-	94	24.8	62.1	32.5
Pericycle	m	70	18	55	18	55	30	20	45	50	30	35	15
	M	97	50	90	50	90	55	38	70	80	43	75	45
	*	90	35	80	35	80	47	27	55	65	36	50	22
	**	87	36.6	77.7	34.3	75.8	43.6	28	57.2	67.2	37.7	45.5	23.3
Xylem	m	90	17	40	17	35	17	18	25	60	40	30	8
	M	103	35	100	35	85	55	38	50	105	60	55	25
	*	95	30	65	30	45	22	33	33	80	45	36	15
	**	97.6	27.5	68	29.4	55.5	31	32.9	35.3	82.5	54	38.8	15
Phloem	m	90	17	40	32	50	20	35	30	40	9	45	15
	M	119	29	70	47	85	45	55	60	60	27	95	35
	*	115	20	55	37	65	25	47	43	53	13	60	20
	**	111	22.4	56.5	27	66.4	29.2	44.7	46.9	57.5	15.7	62	22
Pith	m	-	-	-	-	40	12	70	22	20	8	55	15
	M	-	-	-	-	68	30	120	57	30	15	85	40
	*	-	-	-	-	45	15	74	35	30	13	70	29
	**	-	-	-	-	52.1	16.9	89	36.2	45	12.3	70.7	28.4
Stone cell	m	-	-	-	-	-	-	-	-	-	-	55	16
	M	-	-	-	-	-	-	-	-	-	-	85	45
	*	-	-	-	-	-	-	-	-	-	-	63	28
	**	-	-	-	-	-	-	-	-	-	-	64.5	29.3

Table 3. Microscopical measurement (µm) of the petioles of the various species of Polygonaceae.

Plant parts		*Rumex hastatus*		*Rumex dentatus*		*Rumex nepalensis*		*Rheum australe*		*Persicaria maculosa*	
		L	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Epidermis	m	29	6	17	7	29	20	30	12	35	10
	M	45	15	35	18	60	27	52	25	60	17
	*	32	8	25	12	42	24	45	15	45	13
	**	33.9	9	23.8	12.5	42.9	24.3	43.8	15.8	46	13.2
Parenchyma	m	12	4	15	6	22	10	47	17	22	10
	M	25	10	25	13	40	15	78	30	45	25
	*	15	5	20	8	31	12	32	22	33	22
	**	16.9	5.8	20.1	8.9	31	13.5	35.2	24.3	34.2	20.7
Collenchyma	m	17	8	17	8	37	15	-	-	-	-
	M	45	17	35	14	60	32	-	-	-	-
	*	25	12	22	11	50	22	-	-	-	-
	**	27.7	11.7	23.7	11.3	50.1	23.9	-	-	-	-
Sclerenchyma	m	-	-	-	-	-	-	70	65	45	16
	M	-	-	-	-	-	-	150	135	60	40
	*	-	-	-	-	-	-	95	88	55	22
	**	-	-	-	-	-	-	97	93	53.7	24.4
Endodermis	m	17	7	12	5	17	8	-	-	23	6
	M	32	16	19	8	29	17	-	-	45	20
	*	30	14	14	7	22	12	-	-	30	8
	**	27.3	13	14	6.5	21.7	12.1	-	-	34.2	9.9
Pericycle	m	30	12	17	5	25	18	30	12	45	17
	M	55	22	40	15	55	25	52	25	75	30
	*	45	17	25	9	37	23	45	15	60	21
	**	43.2	16.6	25.9	9.4	40	22.8	43.8	15.8	57.3	22.1
Xylem	m	30	15	35	12	37	6	47	17	44	15
	M	52	30	50	21	60	22	78	30	60	27
	*	35	19	42	15	43	13	32	22	51	18
	**	38.2	21.8	41.7	15.5	45.4	13.8	35.2	24.3	52.6	18.7
Phloem	m	15	7	35	15	40	12	30	12	29	10
	M	27	13	57	25	60	33	52	25	60	19
	*	22	10	49	18	55	17	45	15	35	15
	**	21.4	9.3	47.7	18.7	50.6	18.6	43.8	15.8	41.3	14
Pith	m	-	-	-	-	37	9	40	15	12	5
	M	-	-	-	-	60	17	75	30	32	12
	*	-	-	-	-	44	12	60	27	18	7
	**	-	-	-	-	45.5	12	58	24.9	18.4	9

Table 4. Microscopical measurement (µm) of the leaves of the various species of Polygonaceae.

Plant parts		*Rumex hastatus*		*Rumex dentatus*		*Rumex nepalensis*		*Rheum australe*		*Persicaria maculosa*		*Polygonum plebejum*	
		L	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**	**L**	**W**
Epidermis	m	25	17	145	45	175	45	95	40	25	12	65	30
	M	80	25	215	90	195	90	160	70	55	30	90	40
	*	43	16	175	85	163	65	130	55	35	18	60	29
	**	42.9	14	160	88	155	62	132	57.2	40	22	60.8	28.8
Parenchyma	m	-	-	-	-	-	-	45	25	-	-	-	-
	M	-	-	-	-	-	-	70	45	-	-	-	-
	*	-	-	-	-	-	-	51	33	-	-	-	-
	**	-	-	-	-	-	-	55	32.3	-	-	-	-
Collenchyma	m	60	25	-	-	-	-	-	-	-	-	39	10
	M	90	40	-	-	-	-	-	-	-	-	75	29
	*	65	35	-	-	-	-	-	-	-	-	55	17
	**	68.5	32.8	-	-	-	-	-	-	-	-	55.4	18.5
Sclerenchyma	m	-	-	-	-	-	-	70	19	35	12	70	30
	M	-	-	-	-	-	-	100	33	50	20	120	50
	*	-	-	-	-	-	-	80	22	39	14	85	45
	**	-	-	-	-	-	-	83	23.1	41.1	15.2	79	41.5
Endodermis	m	53	9	30	9	40	19	-	-	19	6	-	-
	M	90	25	50	18	60	30	-	-	40	15	-	-
	*	60	17	37	14	45	22	-	-	25	8	-	-
	**	65.8	16.1	38.2	13.8	48.7	23.5	-	-	27.3	9	-	-
Pericycle	m	47	17	40	10	60	18	45	11	19	8	-	-
	M	75	29	60	18	85	35	70	30	40	17	-	-
	*	55	20	45	15	70	25	55	17	22	11	-	-
	**	57.2	20.6	48.9	14.7	72.4	25.6	57.2	17.6	24.5	11.5	-	-
Xylem	m	40	6	35	8	35	12	25	6	30	10	25	11
	M	70	19	60	24	53	25	50	14	50	19	60	25
	*	45	9	43	11	45	16	33	8	35	13	35	16
	**	48	11.2	45.4	13	47.5	16.4	35.3	9	40	13.3	39	16.1
Phloem	m	45	17	55	11	45	19	30	6	40	9	45	11
	M	105	29	88	21	90	29	60	15	60	25	75	18
	*	55	21	65	18	63	21	43	10	49	14	60	14
	**	61.5	21.7	70.7	17.2	66	22.2	46.9	10.8	49.4	14.6	60.5	14.3
Pith	m	-	-	35	15	-	-	45	12	35	13	50	9
	M	-	-	50	28	-	-	70	25	65	30	80	22
	*	-	-	41	22	-	-	49	17	43	20	55	13
	**	-	-	41.5	22.3	-	-	53.3	17.1	49.2	20.7	59.5	14.3
Mesophyll	m	70	8	70	5	80	11	55	25	15	8	90	18
	M	110	25	100	13	105	29	105	40	30	18	150	29
	*	88	12	92	8	85	18	65	35	19	12	115	23
	**	88	14.9	90	8.2	89.5	18.4	70	36	19.6	12.3	121.5	22.6

M = Maximum, m = minimum, * = Mean, ** = Frequent value.

10 readings were taken for each cell length and width.

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