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ANATOMICAL STUDIES ON *Verbascum bugulifolium* Lam. (Riva Mullein)

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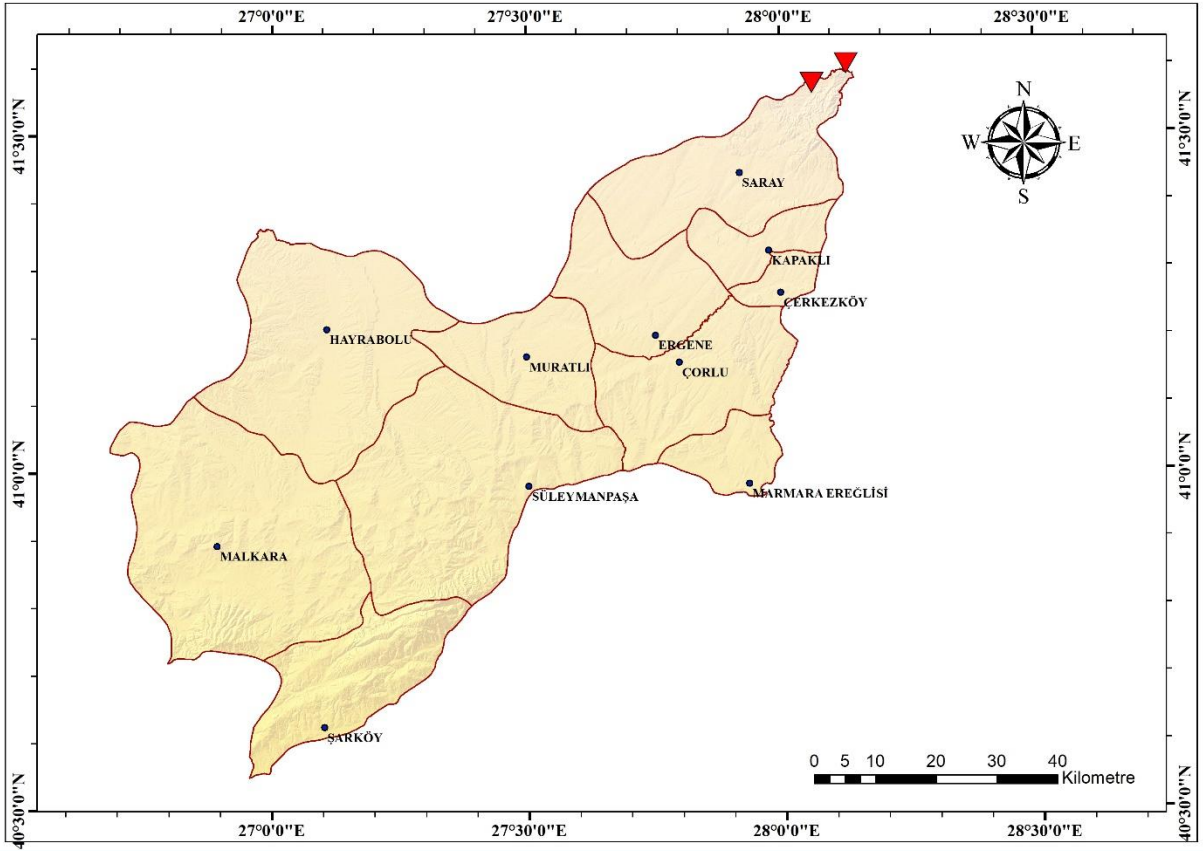
***Verbascum bugulifolium* Lam.**

Introduction

- The genus *Verbascum* L. contains approximately 360 species worldwide.
- In Turkey, There are 255 species and 106 hybrids which belongs 12 different artificial groups.
- 198 of these taxa are Turkish endemics and endemism ratio is more than 50%.
- *Verbascum bugulifolium* Lam. has a narrow distribution in Northwestern part of Turkey and IUCN category evaluated as EN .

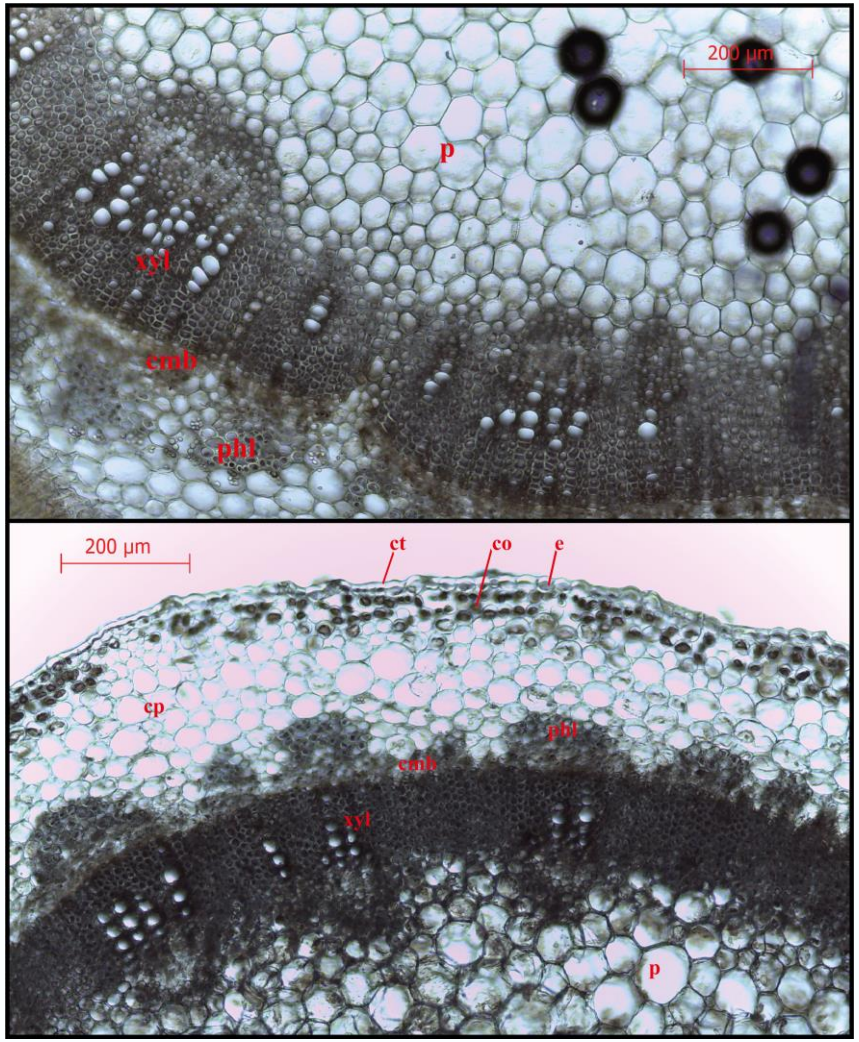
Plant Material 3



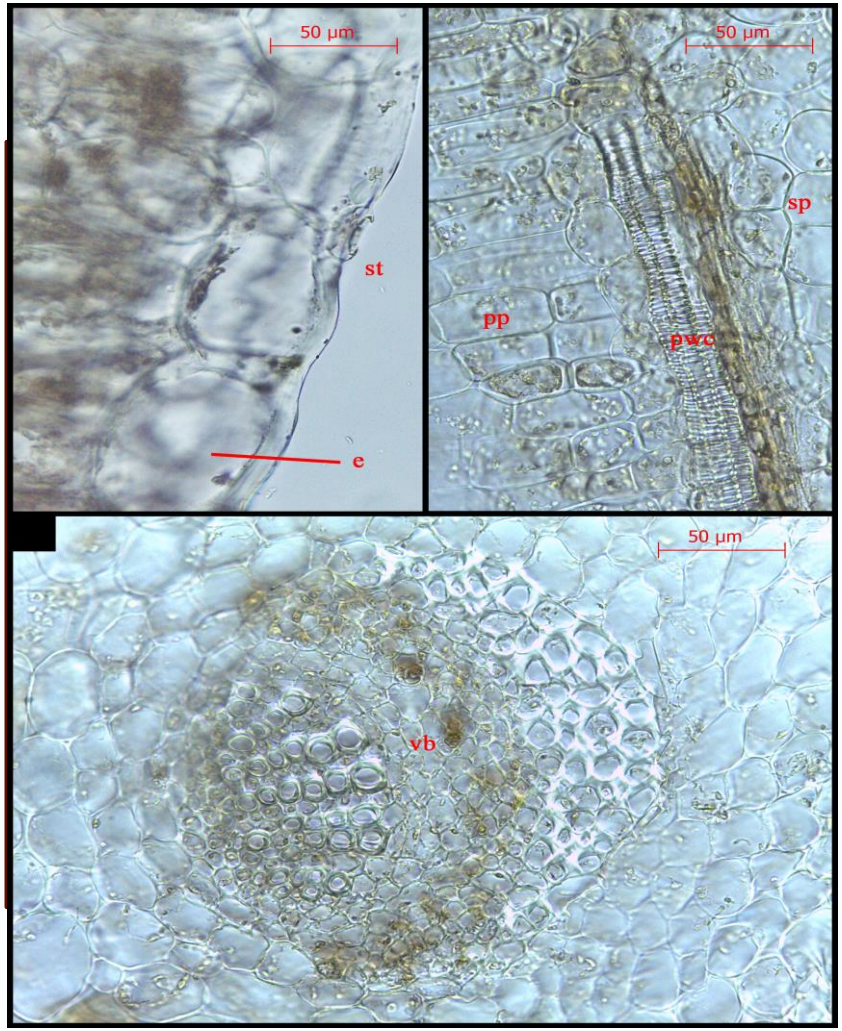
- Bahçeköy to Kıyıköy, 12 km before Kıyıköy, 140 m, 23 v 2019, O. Demir OD1166 et A. Kızılırmaklı (NGBB).
- Çamlıköy Nature Park to Bahçeköy, 108 m, 23 v 2019, O. Demir OD1168 et A. Kızılırmaklı (NGBB).

- The detailed anatomical structures of the root, stem and basal leaf were investigated according to the methods of Metcalfe and Chalk (1979).

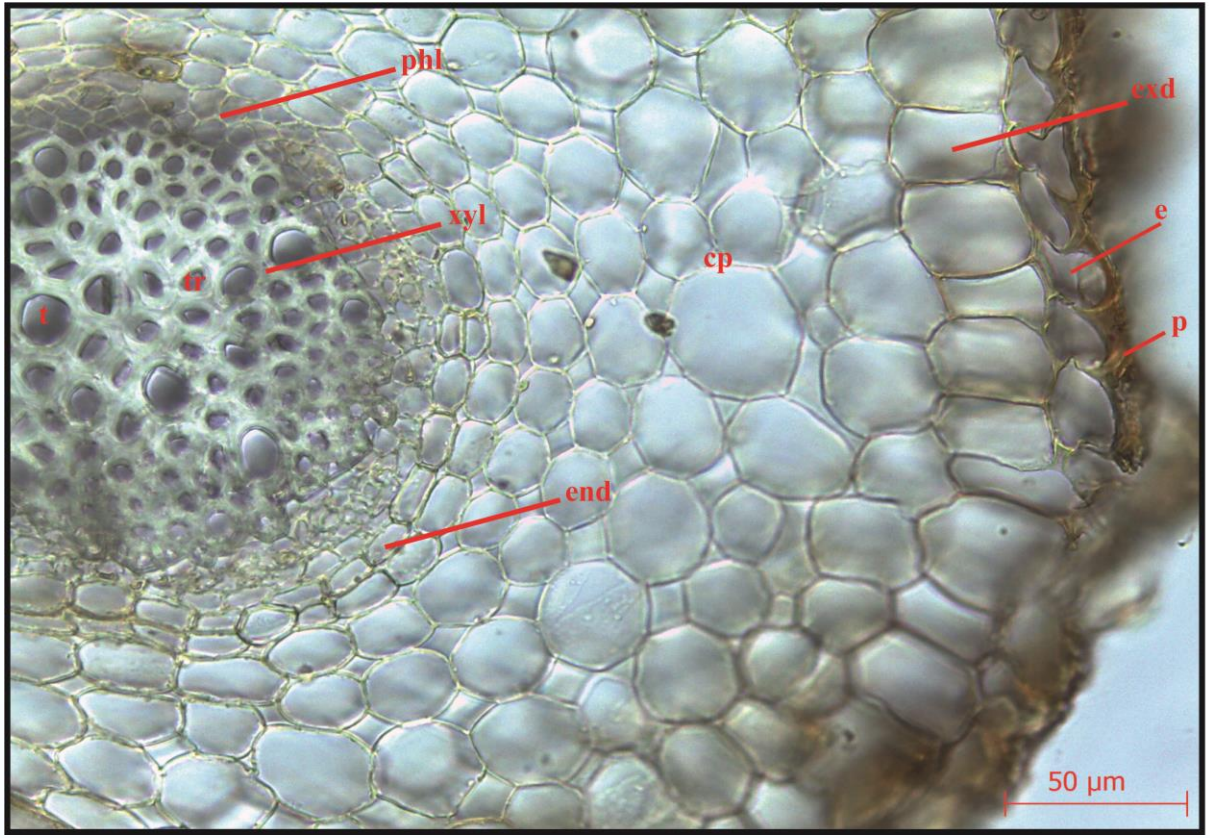
- In order to determine the vegetative and generative organs of *V. bugulifolium* (stem, leaf surface and flower organs (calyx and corolla), trichome structures, the relevant plant parts were examined with a Leica DM750 camera light microscope and photographs were taken. The images of the trichome structures were processed with the GIMP program (The GIMP Development Team, 2020).



- p: parenchymatic cell,
- xyl: xylem,
- cmb: cambium,
- phl: phloem,
- cp: cortex parenchyma,
- co: collenchyma,
- e: epidermis;
- ct: cuticle



- sp: spongy parenchyma,
- pp: palisade parenchyma,
- vb: vascular bundle,
- e: epidermis,
- st: stoma



- t: trachea,
- tr: tracheid,
- xyl: xylem,
- phl: phloem,
- end: endodermis,
- cp: cortex parenchyma,
- exd: exodermis,
- e: epidermis,
- p: periderm

Measurements 8

Structure	Width (µm)			Length (µm)		
	Min	Max	Mean ± SD	Min	Max	Mean ± SD
Stem						
Parenchymatic cell	26	83	49,53 ± 14,49	30	104	59,62 ± 20,50
Tracheid cell	10	19	15,08 ± 3,00	7	17	12,59 ± 3,19
Pith cell	17	31	22,85 ± 3,79	12	26	19,26 ± 3,53
Cambium cell	7	16	11,37 ± 2,24	5	9	6,29 ± 1,16
Floem cell	10	18	14,39 ± 2,69	8	16	11,06 ± 2,42
Cortex parenchyma cell	23	66	39,87 ± 12,13	17	59	32,97 ± 12,35
Cortex Region	-	-	-	74	224	119,30 ± 51,43
Collenchyma cell	12	27	18,44 ± 3,39	13	22	15,93 ± 3,20
Epidermis cell	16	33	23,50 ± 4,76	9	16	12,14 ± 2,47
Cuticle	-	-	-	6	10	8,34 ± 1,39
Basal Leaf						
Spongy parenchyma cell	25	38	26,92 ± 1,61	24	37	30,41 ± 5,69
Palisade parenchyma cell	17	22	20,32 ± 1,57	45	60	54,90 ± 5,67
Vascular bundle	189	423	270,53 ± 107,91	166	387	248,51 ± 98,51
Epidermis cell	21	35	28,27 ± 5,04	16	21	18,81 ± 1,99
Cuticle	-	-	-	0,45	0,63	0,52 ± 0,06
Root						
Tracheid cell	6	11	9,20 ± 1,90	4	9	6,26 ± 2,07
Trachea cell	22	41	30,86 ± 8,03	23	41	29,80 ± 7,19
Endodermis cell	12	15	14,14 ± 1,09	6	10	7,49 ± 1,12
Cortex parenchyma cell	24	38	30,21 ± 4,10	24	35	28,88 ± 3,97
Cortex Region	-	-	-	73	108	89,20 ± 12,47
Exodermis cell	11	31	20,99 ± 7,28	27	35	31,43 ± 2,98
Epidermis cell	20	23	21,66 ± 1,49	14	16	15,12 ± 0,82

Structure	Shape
Stem	
Floem cell	Orbicular and ovate
Tracheid cell	Mostly rectangular, pentagonal, hexagonal, rarely trigonal and square
Pith	Mostly orbicular
Cambium cell	Mostly rectangular, pentagonal, hexagonal, rarely trigonal and square
Parenchymatic cell	Orbicular, ovate, pentagonal, hexagonal
Cortex parenchyma cell	Orbicular and ovate
Cortex Region	-
Collenchyma cell	Orbicular and ovate
Epidermis cell	Mostly ovate rarely orbicular
Cuticula	-
Basal Leaf	
Spongy parenchyma cell	Mostly ovate and orbicular rarely rectangular
Palisade parenchyma cell	Mostly rectangular
Vascular bundle	-
Epidermis cell	Ovate and rectangular
Cuticle	-
Root	
Tracheid cell	Mostly drop shaped and rectangular
Trachea cell	Ovate and orbicular
Endodermis cell	Mostly rectangular, rarely orbicular
Cortex parenchyma cell	Mostly hexagonal, rarely ovate and orbicular
Cortex Region	-
Exodermis cell	Rectangular and hexagonal
Epidermis cell	Mostly rectangular, rarely orbicular

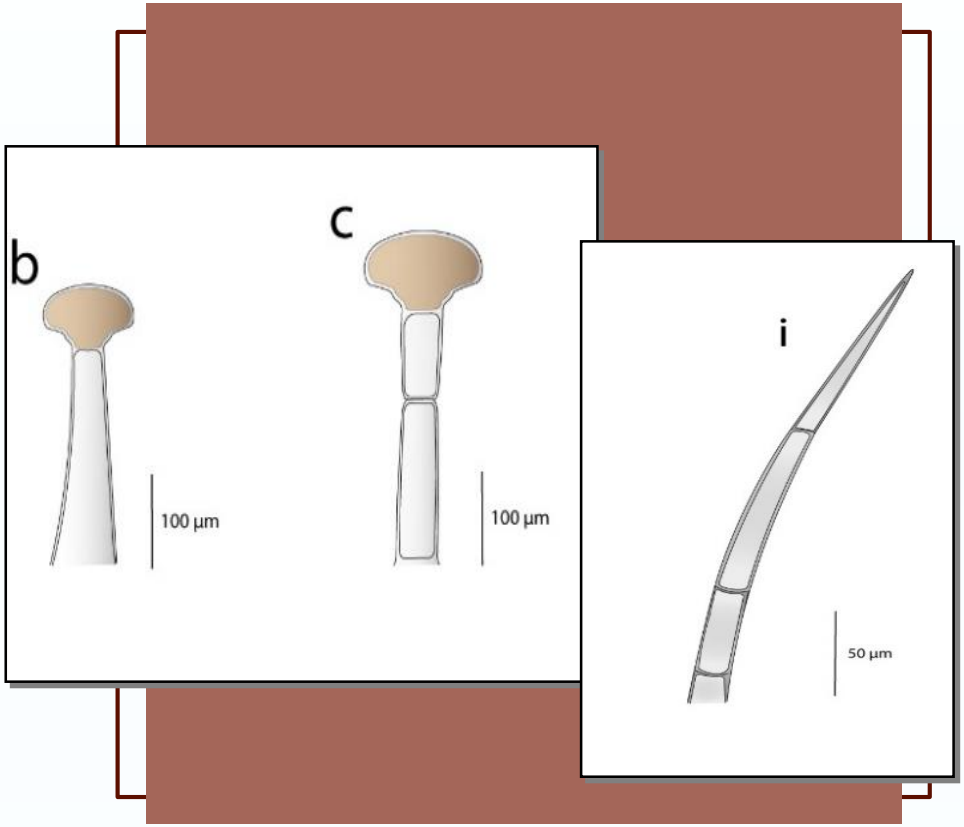
	V. bugulifolium (In this study)	*V. bugulifolium* (Aydınoğlu, 2019)	*V. wiedemannianum* Fisch. & C.A.Mey. (Tekin and Yılmaz, 2018)
Stem			
Floem cell	Orbicular and ovate	-	-
Tracheid cell	Mostly rectangular, pentagonal, hexagonal, rarely trigonal and square	-	-
Pith	Mostly orbicular	-	-
Cambium cell	Mostly rectangular, pentagonal, hexagonal, rarely trigonal and square	-	Rectangular or square, occasionally irregular
Parenchymatic cell	Orbicular, ovate, pentagonal, hexagonal	±Orbicular	-
Cortex parenchyma cell	Orbicular and ovate	±Orbicular	Oval or occasionally circular
Cortex Region	-	-	-
Collenchyma cell	Orbicular and ovate	-	-
Epidermis cell	Mostly ovate rarely orbicular	Rectangular	Rectangular and oval
Cuticula	-	-	-
Basal Leaf			
Spongy parenchyma cell	Mostly ovate and orbicular rarely rectangular	Ovate-Orbicular, 5-6 layered	ovoid or irregular shaped.
Palisade parenchyma cell	Mostly rectangular	Elongated cylindrical shaped	Rectangular, cylindrical or rarely irregular
Vascular bundle	-	-	-
Epidermis cell	Ovate and rectangular	Rectangular, 1 layered	Rectangular-oval
Cuticle	-	-	-
Root			
Tracheid cell	Mostly drop shaped and rectangular	-	-
Trachea cell	Ovate and orbicular	-	-
Endodermis cell	Mostly rectangular, rarely orbicular	-	-
Cortex parenchyma cell	Mostly hexagonal, rarely ovate and orbicular	-	Usually irregular or rarely rectangular-ovoid shaped.
Cortex Region	-	-	-
Exodermis cell	Rectangular and hexagonal	-	-
Epidermis cell	Mostly rectangular, rarely orbicular	-	-

Width (um)

	V. bugulifolium (In this study)	*V. bugulifolium* (Aydınoğlu, 2019)	*V. wiedemannianum* Fisch. & C.A.Mey. (Tekin and Yılmaz, 2018)
Stem			
Parenchymatic cell	49,53 ± 14,49	70-100	-
Tracheid cell	15,08 ± 3,00	-	-
Pith cell	22,85 ± 3,79	-	76,90 ±30,37
Cambium cell	11,37 ± 2,24	-	2,99 ± 0,78
Floem cell	14,39 ± 2,69	-	-
Cortex parenchyma cell	39,87 ± 12,13	5-7,5	20,04 ±8,53
Cortex Region	-	-	-
Collenchyma cell	18,44 ± 3,39	-	-
Epidermis cell	23,50 ± 4,76	20-30	22,30 ±5,8
Cuticle	-	-	-
Basal Leaf			
Spongy parenchyma cell	26,92 ± 1,61	60-70	26,79 ±4,67
Palisade parenchyma cell	20,32 ± 1,57	40 - 50	25,64 ±4,14
Vascular bundle	270,53 ± 107,91	-	-
Epidermis cell	28,27 ± 5,04	40 – 70	21,13 ±4,66 - 25,31 ±4,12
Cuticle	-	-	-
Root			
Tracheid cell	9,20 ± 1,90	-	-
Trachea cell	30,86 ± 8,03	-	49,80 ±24,09
Endodermis cell	14,14 ± 1,09	-	-
Cortex parenchyma cell	30,21 ± 4,10	-	19,03 ±7,96
Cortex Region	-	-	-
Exodermis cell	20,99 ± 7,28	-	-
Epidermis cell	21,66 ± 1,49	-	-

Length (um)

	V. bugulifolium (In this study)	*V. bugulifolium* (Aydınoğlu, 2019)	*V. wiedemannianum* Fisch. & C.A.Mey. (Tekin and Yılmaz, 2018)
Stem			
Parenchymatic cell	59,62 ± 20,50	70-110	
Tracheid cell	12,59 ± 3,19	-	
Pith cell	19,26 ± 3,53	-	92,82 ±34,67
Cambium cell	6,29 ± 1,16	-	8,34 ±1,61
Floem cell	11,06 ± 2,42	-	
Cortex parenchyma cell	32,97 ± 12,35	7,5-10	28,11 ±14,03
Cortex Region	119,30 ± 51,43	--	
Collenchyma cell	15,93 ± 3,20	-	
Epidermis cell	12,14 ± 2,47	30-40	25,81 ±6,71
Cuticle	8,34 ± 1,39	-	1 ± 0,12
Basal Leaf			
Spongy parenchyma cell	30,41 ± 5,69	50-60	39,78 ±7,96
Palisade parenchyma cell	54,90 ± 5,67	50-60	47,07 ±7,88
Vascular bundle	248,51 ± 98,51	-	-
Epidermis cell	18,81 ± 1,99	20-50	26,21 ±5,75 - 28,67 ±4,08
Cuticle	0,52 ± 0,06	-	0,84 ±0,11 - 0,92 ±0,11
Root			
Tracheid cell	6,26 ± 2,07	-	-
Trachea cell	29,80 ± 7,19	-	-
Endodermis cell	7,49 ± 1,12	-	-
Cortex parenchyma cell	28,88 ± 3,97	-	27,82 ±10,42
Cortex Region	89,20 ± 12,47	-	-
Exodermis cell	31,43 ± 2,98	-	-
Epidermis cell	15,12 ± 0,82	-	-



Stem	Basal Leaves	Calyx	Corolla (Outside)
Eglandular (i) and glandular below (b, c), upper glandular (b)	Glabrous	Glandular	Glandular

Thanks

Does anyone have any questions?