ANNALS OF PLANT SCIENCES
ISSN: 2287-688X
OPEN ACCESS
www.annalsofplantsciences.com

ORIGINAL RESEARCH ARTICLE

Studies on the stomata of two medicinally important plants *Aloe abyssinica* and *Haworthia limifolia*

Afrin Nazli and Kamini Kumar*
University Department of Botany, Ranchi University, Ranchi-834008, Jharkhand. India.

Received: November 9, 2015; **Revised:** November 12, 2015; **Accepted:** November 28, 2015.

Abstract: In the present investigation a study on the stomata of two medicinally important plants *Aloe abyssinica* and *Haworthia limifolia* of family Liliaceae was performed. Tetracytic type of stomata were observed in both *Aloe abyssinica* and *Haworthia limifolia*. Maximum stomatal index and stomatal size were reported in *Haworthia limifolia*.

Key words: Stomata, Stomatal Index, *Aloe abyssinica* and *Haworthia limifolia*

Introduction

Aloe abyssinica and *Haworthia limifolia* are xerophytic plants belonging to the family Liliaceae and are indigenous to Africa. Various species of both the genera have been introduced to India and are being grown for horticultural and medicinal values. The fleshy leaves and roots of many species of *Aloe* are used in many traditional treatments [1]. Traditional healers and many pharmaceutical companies utilize mainly the leaf sap of the *Aloe* for the treatments of wounds, burns, rashes, cracked lips and cracked skin [2].

Haworthia limifolia is also used extensively for its medicinal properties, as it contains lectin and lectin like derivatives. It is traditionally used for the treatments of sores, superficial burns, as a blood purifier and to promote pregnancy in both women and cattle [3]. Thus the aim is to study the variations in leaf epidermal anatomy of *Aloe abyssinica* and *Haworthia limifolia* and establish the taxonomic relationship between these two genera of family Liliaceae. Microscopic investigation into the leaf anatomy as well as epidermal scrapping of *Aloe* species can provide crucial information for taxonomic, systematic and identification purposes [4-11].

The stomatal size is considered as cytological criteria according to De Wet [12]. Leaf surface characters can be used as secondary or supporting characters in biosystematics studies [13]. Very little microscopic information is available as a taxonomic method to obtain an anatomical understanding of succulent plants. Most of the anatomical investigations done earlier were only used to locate the cells responsible for storing exudates known as aloe gel due to their high medicinal values [14]. Scanty investigations in leaf surface characteristics of *Aloe abyssinica* and *Haworthia limifolia* to establish their taxonomic relationship had been performed earlier. Therefore, it was found necessary to do a study on the stomata of *Aloe abyssinica* and *Haworthia limifolia* to establish their taxonomic relationship.

Materials and Methods

Fresh leaves of both *Aloe abyssinica* and *Haworthia limifolia* were taken for the study of epidermal anatomical characteristics like stomatal index, shape of epidermal cells and the size of stomata. In *Aloe abyssinica* stomatal studies were done by mechanical peeling off the epidermis from a fresh leaf at apex, middle and base portion of both ventral and dorsal surfaces. In *Haworthia limifolia* it was done by scrapping off the epidermis [15]. Peeled epidermis were then stained in saffranine and then mounted in glycerine. The stomatal index was calculated by using the following formula:

$$\text{Stomatal index} = \frac{\text{No. of stomata per unit area}}{\text{No. of stomata + No. of epidermal cells per unit area}} \times 100$$

Length and width of stomata were measured with the help of stage and ocular micrometer.

Results

Aloe abyssinica and *Haworthia limifolia* belong to family Liliaceae and are xerophytic in nature. Leaves of the above plants were taken for the comparative study of epidermal anatomical characteristics like stomatal index and size of stomata. The stomatal index was calculated from apex, middle and basal portion of the leaves of *Aloe abyssinica* and *Haworthia limifolia*. The results are presented in table 1, figure 5 and 6.

In *Aloe abyssinica*, stomatal index was found maximum at the basal region of ventral surface (5.237 ± 0.327µ) and minimum at apical region of ventral surface (3.632 ± 0.331µ). Whereas, in *Haworthia limifolia* stomatal index was reported maximum at the apical region of dorsal surface (7.501 ± 0.788µ) and minimum at basal region of ventral surface (3.876 ± 0.304µ).

The length of stomata in *Aloe abyssinica* was found maximum at apical and middle region of dorsal surface (39.36 ± 0.816µ) and minimum at apical and basal region of ventral surface (37.44 ± 0.614µ) while in *Haworthia limifola,* maximum length of stomata was found at apical region of dorsal surface (48.0 ± 0.848µ) and minimum at basal region of ventral surface (40.32 ± 0.967µ).

The width of stomata in *Aloe abyssinica* was found maximum at apical region of dorsal surface (34.368 ± 0.498µ) and

***Corresponding Author:**
Dr. (Mrs.) Kamini Kumar,
University Department of Botany,
Ranchi University, Ranchi - 834008
Jharkhand, India.

minimum at apical region of ventral surface (26.304 ± 0.761μ) whereas in *Haworthia limifolia*, maximum width was reported at apical region of dorsal surface (43.0 ± 0.856μ) and minimum at basal region of ventral surface (33.024 ± 0.96μ).

Table 1: Stomatal index, length and width of stomata (in μ) of dorsal and ventral surface of leaves of *Aloeabyssinica* and *Haworthia limifolia*

Surface	Plant	Apex			Middle			Base		
		S.I.	Length (μ)	Width (μ)	S.I.	Length (μ)	Width (μ)	S.I.	Length (μ)	Width (μ)
Dorsal	*Aloe abyssinica*	4.015 ± 0.390	39.360 ± 0.816	34.368 ± 0.498	3.875 ± 0.223	39.360 ± 0.402	33.024 ± 0.448	4.038 ± 0.508	38.016 ± 0.360	30.528 ± 0.681
	Haworthia limifolia	7.501 ± 0.788	48.000 ± 0.848	43.000 ± 0.856	7.226 ± 0.753	47.616 ± 1.281	40.704 ± 0.881	4.915 ± 0.699	41.472 ± 0.813	35.136 ± 0.891
Ventral	*Aloe abyssinica*	3.632 ± 0.331	37.440 ± 0.614	26.304 ± 0.761	5.041 ± 0.571	38.784 ± 0.448	27.264 ± 0.840	5.237 ± 0.327	37.440 ± 0.614	28.992 ± 1.405
	Haworthia limifolia	6.019 ± 0.650	46.080 ± 0.804	37.824 ± 0.660	5.480 ± 0.392	46.656 ± 0.931	35.904 ± 0.761	3.876 ± o.304	40.320 ± 0.967	33.024 ± 0.960

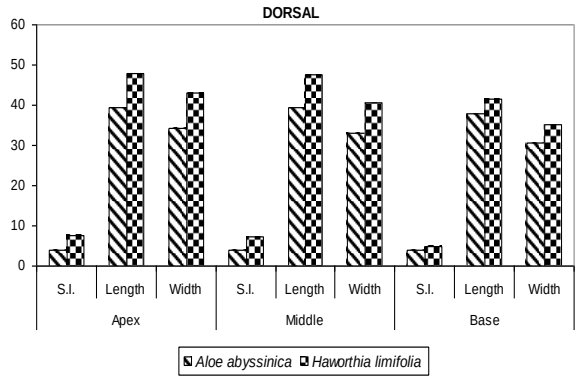

Figure 5: Graph showing comparative stomatal index, length and width (□) of stomata in dorsal surface of *Aloe abyssinica* and *Haworthia limifolia*

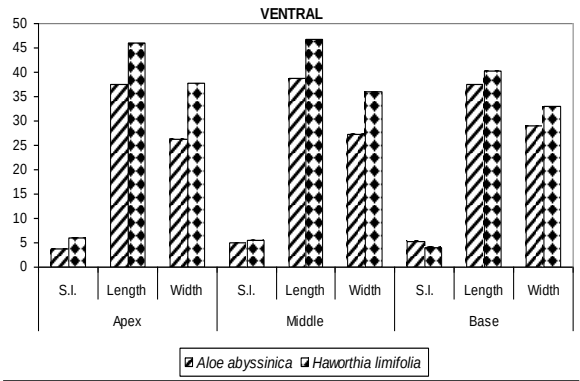

Figure 6: Graph showing comparative stomatal index, length and width (□) of stomata in ventral surface of *Aloe abyssinica* and *Haworthia limifolia*

Figure 1

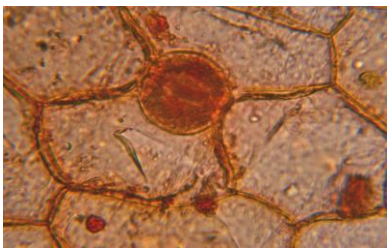

Figure 2

Figure 3

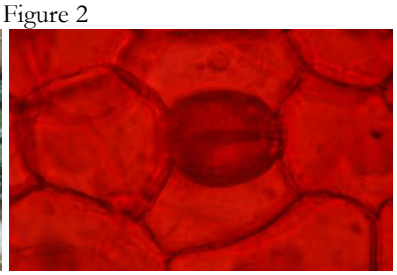

Figure 4

Photographs and Photomicrographs of Stomata of *Aloe abyssinica* Lam and *Haworthia limifolia*. Fig. 1 and 2 *Aloe abyssinica* Lam, Fig. 3 and 4 *Haworthia limifolia*

Discussion

In both *Aloe abyssinica* and *Haworthia limifolia*, tetracytic stomata was found with two guard cells surrounded by four subsidiary cells and the subsidiary cells were in all four directions. Stomata were deeply sunken with apertures which is a characteristic of plants growing in water stressed condition. Similar characters were observed by Brandham and Cutler, 1978 in hybrid *Aloe* [16]. In both *Aloe abyssinica* and *Haworthia limifolia* an amphistomatic nature of leaves having stomata on both sides were found. Although a difference was reported in parameters like stomatal index, length and width of stomata between *Aloe abyssinica* and *Haworthia limifolia*. Epidermal characteristics that are epidermal cells and stomata have been proven to be an important taxonomic tool in distinguishing medicinal plants [17]. Stomatal function is important as it is significant in evolutionary history to atmospheric to environmental sciences. Various studies have been emphasized the

significance of foliar anatomy in the systematic of various plant groups. Thus suggesting that leaf surface pattern, anatomical features and structures are genetically controlled. Stomata size is positively correlated with genome size across a wide range of major taxa. Stomatal size predicts genome size within the angiosperms [18]. Stomatal structure, frequency, size of stomatal apertures are important factors that determine the transpiration rates. The distribution of stomata and their number are important factors for determination of susceptibility or resistance. Present result shows that all the three parameters that is stomatal index, length and width of stomata was found higher in *Haworthia limifolia* when compared with *Aloe abyssinica* which indicates that the transpiration rate might be higher in *Haworthia limifolia*.

Although the epidermal features such as stomatal position, size and surface papillation in *Aloe* are species specific and varied from one species to another, these variations have been attributed to direct genetic control as well as environmental variables [19].

Conclusions

On the basis of above findings, it may be concluded that both *Aloe abyssinica* and *Haworthia limifolia* closely related taxonomically as both the above plants bear Tetracytic type of stomata which were deeply sunken with apertures which is a characteristic of plants growing in water stressed condition. In both the plants amphistomatic nature of leaves having stomata on both sides are found. However, there were differences observed in stomatal index, length and width of stomata.

Research highlights

The investigation revealed that both the *Aloe abyssinica* and *Haworthia limifolia* are related genera. Both the above plants bear tetracytic type of stomata which were deeply sunken with apertures. In both the plants amphistomatic nature of leaves having stomata on both sides were found. All the three parameters that is stomatal index, length and width of stomata was found higher in *Haworthia limifolia* when compared with *Aloe abyssinica* which indicates that the transpiration rate might be higher in *Haworthia limifolia*.

Limitations

Both the *Aloe abyssinica* and *Haworthia limifolia* were locally collected from Ranchi (Jharkhand, India) and the present study was performed in the laboratory of University Department of Botany, Ranchi University, Ranchi.

Recommendations

Microscopic investigation into the leaf anatomy and epidermal scrapping can provide crucial information for taxonomic, systematic and identification purposes.

Funding and Policy aspects

Identification of medicinal plants of Ranchi, Jharkhand.

Justification of research

Anatomical and taxonomical understanding of medicinal plants of Ranchi, Jharkhand.

Acknowledgement

We express our sincere gratitude to University Department of Botany, Ranchi University, Ranchi, Jharkhand for providing the laboratory facilities.

References

1. Mabberley, D.J. "The Plant Book: A portal dictionary of the higher plants." Cambridge University Press, Cambridge. (1987). 21. Print.
2. Cera, L.M., J.P. Heggers., M.C Robson. and, M.R. Duraccia. "The therapeutic efficacy of *Aloe vera* cream (Darmide Aloe) in dernal injuries: two case reports". J. Am. Anim. Hos. Ass., 16(1980): 768 - 772. Print.
3. Coopoosamy, R.M. and K.K. Naidoo. "Screening of traditional utilized *Haworthia limifolia* for antibacterial and antifungal properties." J. Med. Plant Res**.** 5.1. (2011): 109 - 113. Print.
4. Reynolds, G.W. "The Aloes of Tropical Africa and Madagascar." Aloes Book Fund, Mbabane. (1966) Print.
5. Cutler, D.F. "Cuticular Marking and other Epidermal Features in Aloe Leaves." Notes from the Jodrell Laboratory, 6. (1969): 21 - 27. Print.
6. Cronquist, A. "An Integral System of Classification of Flowering Plant." New York: Columbia University Press, (1981). 1215. Print.
7. Dahlgren, R.M.T. and H.T. Clifford. "The Mono-cotyledon: a comparative study." Acad. Press Londn. (1982). 28. Print.
8. Cutler, D.F. "Taxonomic and Ecological Implications of Leaf Surface Features in *Aloe* and *Haworthia* (Liliaceae) as seen with the SEM." Proc. Royal Microscop. Soc. (1985) 20 - 23. Print.
9. Dahlgren, R.M.T., H.T. Clifford and P.F. Yeo. "The Families of Monocotyledon; Structure, Evolution and Taxonomy." Springer-Verlag, Berlin. (1985). 179 - 182. Print.
10. Beaumont, J, D.F. Cutler, T. Reynolds and J.G. Vaughan "The Secretory Tissue of Aloes and Their Allies." Isr. J. Bot., 34(1985).: 265 - 282. Print.
11. Beaumont, J., D.F. Cutler, T. Reynolds and J.G. Vaughan. "Secretory Tissues in the East Africa Shrubby Aloes." Bot. J. Linnean Soc. 92(1986): 399 - 402. Print.
12. De Wet, M.J. "Stomatal size as a cytological criterian in Danthonia." Cytologia. 19(1954): 176 - 181. Print.
13. Shiva Kameshwari, M.N., A. Bijul Lakshman and Para-masivam. "Biosystematic studies on Medicinal Plant *Urginea indica* Kunth. Liliaceae: A Review." Int. Journ. Pharm. Life Sci. 3.1. (2012): 1394 - 1406. Print.
14. Hirata, T. and T. Suga. "Biological active Constituents of Leaves and Roots of *Aloe arborescens* var. Natalensis." Z. Naturforsch C, 32(1977): 731 - 734. Print.
15. Topno and T.K Ghosh. Comparision of epidermal character of Cassia Linn. *Columban J. Life Sci.* **5.**1 and 2. (1997): 239 – 242. Print.
16. Brandham, P.E. and D.F. Cutler. "Influence of Chromosome Variations on the organisation of the leaf epidermis in hybrid Aloe (Liliaceae)." Bot. J. Linnean Soc., 77(1978): 1 - 16. Print.

17. Johri, A. "Epidermal characters of some ornamental plants used in Traditional medicine." Advance in Plant Science, 26.1. (2013): 153 - 155. Print.

18. Hadgson, J.G., *et al.,* "Stomatal vs. Genome size in angiosperms': the somatic tail wagging the genomic dog?" Annals of Botany. 105(2010): 573 - 584. Print.

19. Cutler, D.F. "Cuticular sculpturing and Habitat in Certain Aloe species (Liliaceae) from Southern Africa." In The Plant Cuticle, Ed. Cutler, D.F., K.L. Alvin. and, C.E. Price. Acad. Press, London. (1982). 425 - 444. Print.

Cite this article as:
Afrin Nazli and Kamini Kumar. Studies on the stomata of two medicinally important plants *Aloe abyssinica* and *Haworthia limifolia*. *Annals of Plant Sciences* 4.12 (2015): 1239-1242.

Source of support: University Department of Botany, Ranchi University, Jharkhand, India.
Conflict of interest: None Declared