



Received on 05 September 2018; received in revised form, 29 September 2018; accepted, 30 September 2018; published 01 October 2018

## COMPARATIVE INVESTIGATION OF CALCIUM OXALATE CRYSTALS RELATED TO STARCH STORAGE IN THREE VARIETIES OF *DIOSCOREA ALATA* LINN. OF WAYANAD DISTRICT

P. Sruthi\* and A. K. Abdussalam

Department of Post Graduate Studies and Research in Botany, Sir Syed College, Taliparamba, Kannur - 670142, Kerala, India.

### Keywords:

*Dioscorea alata*,  
Raphides, Calcium oxalate

### Correspondence to Author:

P. Sruthi

Research Scholar, CSIR JRF,  
Department of Post Graduate Studies  
and Research in Botany, Sir Syed  
College, Taliparamba, Kannur -  
670142, Kerala, India.

E-mail: sruthipachen@gmail.com

**ABSTRACT:** Yam is one of the staple foods for several people, used as various forms such as flour and starchy paste. It is locally available, a rich source of starch, so tubers of *Dioscorea* ensure rural food security. The member of the family Dioscoreaceae is found throughout the tropical and warm temperate regions of the world. Calcium oxalate crystals and missile like raphides are reported in many Yam species especially *D. rotundata*. The presence of calcium crystals is related to starch storage. In the present study, calcium oxalate crystals are found in the form of raphides are observed in three varieties of *Dioscorea alata* (*Ginger kachil*, *Red kachil*, and *Neendi kachil*). Microscopical evaluation of stem is done with the help of Leica M 80 Stereomicroscope. The structure and position of raphides are different in each variety. Three varieties of *Dioscorea alata* *Ginger kachil*, *Red Kachil*, and *Neendi kachil*, (these terms were used by Pulaya Communities of Wayanad, based on the morphological features of stem tuber) are used for the present study. In *D. alata*, (*Ginger kachil*) raphides are only seen in pith along the parenchymatous wall. Raphides are found along the cortex in *D. alata* (*Red kachil*) in the form of vertical needle-like structure. In *Red Kachil*, raphides are not observed in pith. In *D. alata* *Neendi kachil*, raphides are found along the cortex as well as pith. Two different types of raphides are observed in this variety, vertical form in pith and clumped form in the cortex. Among the three varieties of *Dioscorea alata*, the quantity of raphides is more in *D. alata* var. *Neendi kachil*.

**INTRODUCTION:** Yam is one of the staple foods for several people, used as various forms such as flour and starchy paste. It is locally available, is a rich source of starch, so tubers of *Dioscorea* ensures rural food security. Tubers produced from *Dioscorea alata*, *D. bulbifera*, *D. caryensis*, *D. dumetorum*, *D. esculenta*, *D. hispida*, *D. opposita*, *D. rotundata* and *D. trifida* are serving as foodstuff for the people in the Far East<sup>1</sup>.

*Dioscorea* species are well known for the presence of steroidal sapogenin (Diosgenin) precursor for the synthesis of steroidal drugs. Diosgenin is a steroidal sapogenin used in oral contraceptives. There were nineteen species of *Dioscorea* has already been reported in Kalpetta, Wayanad from various studies<sup>2, 3, 4</sup>. More than 25 wild plant species/types in Wayanad are known for edible roots, tubers, and rhizomes and are eaten by the tribe and non-tribe communities of the district. *Dioscorea* is rich in starch, but it has no better position in our food system because the place of yam was replaced by other tubers such as cassava, sweet potato, etc. In South America, the position and culture of yam have been replaced by other varieties such as wheat, corn, bean and rice

	<p>QUICK RESPONSE CODE</p>
	<p>DOI: 10.13040/IJPSR.0975-8232.IJP.5(10).678-81</p>
<p>The article can be accessed online o www.ijjournal.com</p>	
<p>DOI link: <a href="http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.5(10).678-81">http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.5(10).678-81</a></p>	

varieties<sup>5</sup>. But nowadays few species of *Dioscorea* are cultivated as food crops such as *D. rotundata*, *D. alata*, *D. caryensis*, *D. dumetorum*, *D. esculenta*, *D. bulbifera*, etc. *Dioscorea* is rich in starch<sup>6,7</sup> and vitamins<sup>8</sup>, etc. The members of the family Dioscoreaceae is found throughout the tropical and warm temperate regions of the world. Calcium oxalate crystals and missile like raphides are reported in many Yam species especially *D. rotundata*. The presence of calcium crystals is related to starch storage. In the present study, calcium oxalate crystals are found in the form of raphides are observed in three varieties of *Dioscorea alata* (*Ginger kachil*, *Red kachil*, and *Neendi kachil*). The role of calcium oxalate crystals in each plant is different. Even in the different tissues, its function may vary. Its functions are the removal of the toxic compound; act as a reservoir of calcium, plant pathogen defense, tissue support etc.<sup>9,10,11</sup>

**MATERIALS AND METHODS:** According to Benthem and Hookers classification, *Dioscorea* belongs to Monocotyledonae under the series Epigyne. Identification of different species of *Dioscorea* is very difficult. Its climbing patterns, nature of stipule, bracts, the shape of tubers are the main key characters for identification. Different varieties of *D. alata* are set up from Wayanad. They are *Chuvappu kachil*, *Ginger kachil*, *Neendi kachil*, *Thunnan kachil*, *Urullan kachil*, *Kuyikka vitthu*, *Quinten kachil*, *Kaduvakayyan kachil*, *Parichakodan kachil*, *Vazhavadakkan kachil* and *Kolli kachil*. The weight of each *dioscorea* varies based on ecological factors; rich fertile soil produces large tubers. So the weight of tubers is not a significant character throughout the identification.

During the favorable condition, *ginger kachil* produces tubers as much as *Quinten kachil*. So the weight of the tubers is not a criterion for identification. So the following taxonomic characters are used for identification; Climbing plants with a fleshy tuberous rootstock, Leaves are opposite or alternate with reticulate leaves, Flowers regular, small and minute, usually unisexual flowers with inferior ovary, perianth tubular, male flower -stamens 3 or 6, trimerous, female flower - 3 or 6 staminodes, trimerous, ovary inferior, fruit berry or valved capsule. The morphology of tubers has a great role in identification.

The characters of *red kachil* are the outer part of this tuber is in color of beetroot. It is also called as *Chora kachil*, *Blue kachil*. It does not possess particular shape. When it is possessed in boiling water it gives a pleasant smell. But in the case of *Ginger kachil* tuber characters are different from that of *Red kachil*, it produces ginger like tubers; outer in yellow colour, where as inner part is white in colour. Each plant produces more than two tubers. *Neendi kachil* produces long tuber, which is brownish-black in colour. Its more peculiar characters are climbing part is covered with spines. After proper identification plant materials are collected from Wayanad for microscopical evaluation.

Fresh plants of *Dioscorea alata* (three varieties *Ginger kachil*, *Red kachil*, and *Neendi kachil*) were collected from various parts of northern Kerala. Transverse section of five different plants of the same variety is used for the study. Sections were made using a sharp blade from the fresh material. The climber is cut into serial sections, washed in double distilled water. Next step is staining, is done with the help of saffranin. Place a drop of glycerin on a specimen to avoid dehydration. Then pass a clean coverslip through spirit lamp flame and then place on the drop of glycerine. The stained sections were observed under a Leica M 80 Stereo microscope.

**RESULTS AND DISCUSSION:** Transverse section of the three varieties is circular in outline. In *Ginger kachil*, TS of the stem is circular with two wings (**Fig. 1A & B**). Whereas in *Red kachil* and *Neendi kachil* TS of the stem is 3 angular and 4 angular respectively (**Fig. 1C & Fig. E**). The cuticle is generally thin. The epidermis is made up of thin parenchymatous cells. The hypodermis is composed of chlorenchymatous cells. Cortex is divided into two; outer cortex sclerenchymatous and inner cortex parenchymatous. Vascular bundles of the stem are arranged in two concentric circles. The outer and inner ring is composed of two metaxylem elements with phloem. The number of vascular bundle varies from varieties to variety (**Fig. 1A, C & E**).

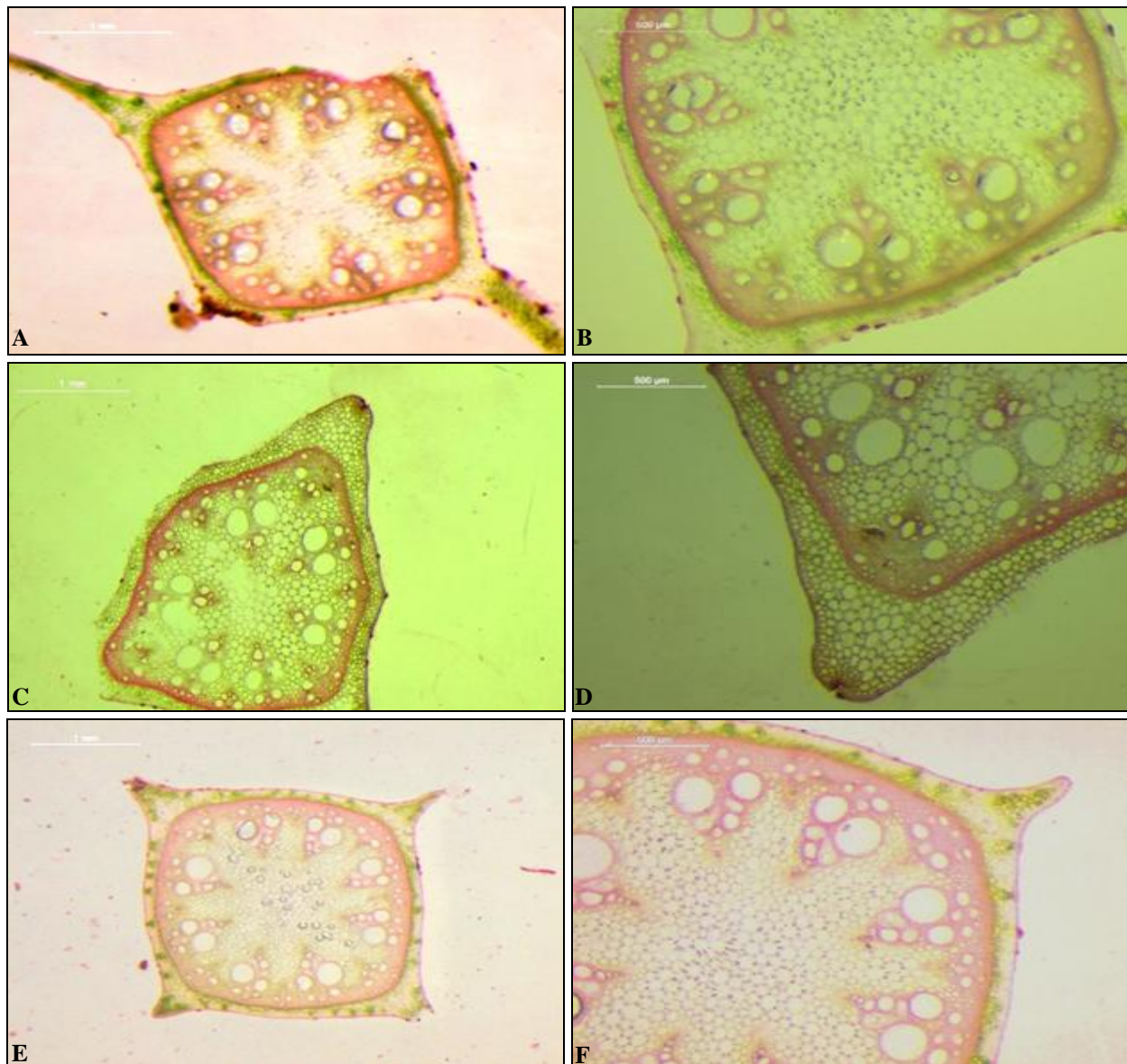
The structure and position of raphides are different in each variety. In *D. alata*, (*Ginger kachil*) raphides are only seen in pith along the

parenchymatous wall (**Fig. 1A & B**). Raphides are found along the cortex in *D. alata* (*Red kachil*) in the form of vertical needle like structure. In *Red kachil*, raphides are not observed in pith (**Fig. 1C & D**). In *D. alata Neendi kachil*, raphides are found along the cortex as well as pith. Two different types of raphides are observed in this variety, vertical form in pith and clumped form in cortex (**Fig. 1E & F**). Among the three varieties of *Dioscorea alata*, the quantity of raphides is more in *D. alata* var. *Neendi kachil*.

The tubers of *Dioscorea* posses several medicinal properties such as antimicrobial, antioxidant and hypoglycemic activities. Due to these properties

they are used against the diseases such as digestive disorder, diarrhoea, irritability, abdominal pain and wound burns *etc.*<sup>12</sup> The antifungal activity was also reported in two species of *Dioscorea*<sup>13</sup>. *Dioscorea* are considers as rich source of different secondary metabolites such as alkaloids, saponins, cholesterol, flavonoids *etc.*<sup>13</sup>

Based on morphology crystals are classified into four types crystal sand, raphide, druse, styloid and prismatic<sup>9, 14, 11</sup>. (These crystals are formed endogenously; first synthesizing oxalic acid and combined with calcium to produce calcium oxalate crystals<sup>11</sup>. Calcium oxalate crystals in the form of raphides are found in three varieties of *D. alata*.



**FIG. 1: A: STEM TS OF *D. ALATA GINGER KACHIL*; B: ENLARGED VIEW OF STEM TS; C: STEM TS OF *D. ALATA RED KACHIL*; D: ENLARGED VIEW OF STEM TS; E: STEM TS OF *D. ALATA NEENDI KACHIL*; F: ENLARGED VIEW OF STEM TS**



**CONCLUSION:** The present study reveals that raphides are common in three varieties of *Dioscorea alata*, but differ in their structure and occurrence. In the variety *Dioscorea alata* var *Ginger kachil*, raphides are absent in cortex, whereas in *red kachil* raphides are absent in pith. In the case of *Dioscorea alata* var. *Neendi Kachil* raphides are present in both cortex and pith.

Based on the shape, two different types of raphides are observed in *Dioscorea alata Neendi kachil* - clumped form as well as vertical needle-like form.

**ACKNOWLEDGEMENT:** The author expresses sincere gratitude to the Council for Scientific and Industrial Research (CSIR) for providing fellowship.

**CONFLICT OF INTEREST:** The authors declare that there is no conflict of interest regarding the above article.

#### REFERENCES:

1. Dutte B: Food and medicinal values of certain species of *Dioscorea* with special reference to Assam. *Journal of Pharmacognosy and Phytochemistry* 2015; 3(4): 15-18.
2. Anilkumar N, Narayanan MKR and Satheesh K: Traditional knowledge of three 'mycophilic' communities on wild edible mushrooms of Wayanad district, Kerala. *Ethnobot* 2008; 20(1): 41-47.
3. Narayanan MKR, Mithunlal S, Sujanalal P, Anilkumar N, Sivadasan M, Alfarhan AH and Alatar AA: Ethno-botanically important trees and their uses by Kattunaikka tribe in Wayanad Wildlife Sanctuary, Kerala, India. *J Med Plants Res* 2013; 5(4): 604-12.
4. Abdussalam AK, Jathina M, Jamsheena K and Ratheesh Chandra P: Phytochemical analysis and GC-MS study of *Dioscorea* (yam) in Wayanad District-Kerala State. *Intl J Innov Scie Res* 2016; 5(01): 588-95.
5. Onwueme IC: *The Tropical Tuber Crops: Yams, Cassava, Sweet Potato and Cocoyams*. John Wiley & Sons Ltd, 1978: 131-32.
6. Coursey DG: *Cassava as Food: Toxicity and Technology. Chronic Cassava Toxicity*, Ottawa, Canada. IDRC-10e 1973: 27-36.
7. Bourret-Cortadellas D: *Ethnobotanical study of the Dioscorea*, Yams New Caledonia. Faculty of Science, Paris, France, 1973: 135-39.
8. Tucker MI, Asemota HN and Ahmad MH: Biochemical composition and storage of Jamaica Yams (*Dioscorea sp.*). *J Sci Food Agric* 1993; 62: 219-24.
9. Franceschi VR and Horner HT: Calcium oxalate crystals in plants. *Bot Rev* 1980; 46: 361-27.
10. Nakata PA: Advances in our understanding of calcium oxalate crystal formation and function in plants. *Plant Sci* 2003; 164: 901-09.
11. Franceschi VR and Nakata PA: Calcium oxalate in plants: formation and function. *Ann Rev Pla Bio* 2005; 56: 41-71.
12. Subash S, Sarla S, Mishra P, Abhay P and Anoop B: Nutritional profile and phytochemical screening of Garhwal Himalayan medicinal of plant *Dioscorea bulbifera*. *International Journal of Pharmacy* 2012; 3(5): 289-94.
13. Ezeocha VC and Ojimelukwe PC: The impact of cooking on the proximate composition and anti-nutritional factors of water yam (*Dioscorea alata*). *Journal of Stored Products and Postharvest Research* 2012; 3(13): 172-76.
14. Horner HT and Wagner BL: Calcium oxalate formation in higher plants. In: Khan SR, editor. *Calcium oxalate in biological systems*. CRC Press; Boca Raton 1995; 45: 53-72.

#### How to cite this article:

Sruthi P and Abdussalam AK: Comparative investigation of calcium oxalate crystals related to starch storage in three varieties of *Dioscorea alata* Linn. of Wayanad district. *Int J Pharmacognosy* 2018; 5(10): 678-81. doi link: [http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.5\(10\).678-81](http://dx.doi.org/10.13040/IJPSR.0975-8232.IJP.5(10).678-81).

This Journal licensed under a Creative Commons Attribution-Non-commercial-Share Alike 3.0 Unported License.

This article can be downloaded to **ANDROID OS** based mobile. Scan QR Code using Code/Bar Scanner from your mobile. (Scanners are available on Google Playstore)