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Relative study of Calcium Oxalate crystals coupled to Starch storage in *Dioscorea alata* Linn. and *Dioscorea bulbifera* Linn of Wayanad District

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Abstract

Yam is one of the chief foods for several people, used as various forms such as flour and starchy paste. It is locally available, rich source of starch so tubers of *Dioscorea* ensure rural food security. By virtue of its excellent palatability, yam is a high value crop widespread throughout the world and forms about 10 % of the total roots and tubers produced in the world. There were nineteen species of *Dioscorea* has already been reported in Kalpetta, Wayanad from various studies. 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 *Dioscorea alata* and *Dioscorea bulbifera.* Microscopical evaluation of stem is done with the help of Leica M 80 Stereomicroscope. The structure and position of raphides are diverse in each species. Two species of *Dioscorea* are used for the current study. In *D.alata*, raphides are only seen in pith along the parenchymatous wall. Rahides are found along the cortex in *D.bulbifera* in the form of vertical needle like structure. In *D.bulbifera*, raphides are not observed in pith. Two different types of raphides are observed in this variety, vertical form in pith and clumped form in cortex. Among the two species of *Dioscorea*, the number of raphides is more in *D.alata*

Key words: *Dioscorea alata,* Raphides, Calcium oxalate

INTRODUCTION

Yam is one of the chief foods for various people, used as different forms such as flour and starchy paste. It is locally accessible, is rich source of starch so tubers of *Dioscorea* guarantees 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* helping as food stuff for the tribal societies in the Far East ([1]Datta, 2015). *Dioscorea* species are well known for the presence of steroidal sapogenin (Diosgenin) originator 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 ([2]Anilkumar *et al*., 2008; [3]Narayanan *et al.*, 2013; [4]Abdussalam *et al*, 2016). In excess of 25 wild plant species/types in Wayanad are recognized for edible roots, tubers and rhizomes and are eaten by the tribe and non-tribe communities of the district. *Dioscorea* are rich in starch, but it have no better position in our food system because the place of yam was substituted by other storage organs such as cassava, sweet potato etc. In South America the place and culture of yam has been substituted by other varieties such as wheat, corn, bean and rice varieties ([5]Onwuemw, 1978). But currently 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* are rich in starch ([6]Coursey, 1973), protein ([7]Cortedellas, 1973) and vitamins ([8]Tucker et al., 1993) .etc. The members of the family *Dioscoreaceae* is found all over the tropical and warm temperate regions of the world. Calcium oxalate crystals and bullet like raphides are reported in many Yam species particularly *D. rotundata*. The occurrence of calcium crystals is connected to starch storage. In the present study calcium oxalate crystals are found in the form of raphides are observed in two species of *Dioscorea, D.alata* and *D.bulbifera*. The role calcium oxalate crystals in each plant are differrent. Even in the various tissues, its function may vary. Its functions are elimination of lethal compound; act as pool of Calcium, plant pathogen resistance, tissue support etc. ([9]Franceschi and Horner 1980; [10]Nakata 2003; [11]Franceschi and Nakata 2005).

MATERIALS AND METHODS

As stated by Benthem and Hookers classification, *Dioscorea* belongs to Monocotyledonae under the series Epigynae. Identification of different species of *Dioscorea* is very challenging. Its climbing arrangements, nature of stipule, bracts, shape of tubers are 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 productive soil produces large tubers. So weight of tubers is not significant character throughout the identification. The following taxonomic characters are used for identification; Climbing plants with a fleshy tuberous root stock, 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, trimorous,ovary inferior, Fruit berry or valved capsule. The morphology of tubers has a great role in identification. The characters of *D.alata* 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 treated with boiling water it produces a pleasant smell. *D.bulbifera* produces long tuber, which is black in colour. Its more peculiar characters are climbing part is cover*ed* with small hairs. After proper identification plant materials are collected from Wayanad for microscopical evaluation.

Fresh plants of *Dioscorea alata* and *Dioscorea bulbifera* were collected from different parts of northern Kerala. Transverse section of five different plants of same species are used for the study. Sections were made using sharp blade from the fresh material. 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 in order 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 Leica M 80 Stereo microscope.

RESULTS AND DISCUSSION

Transverse section of the three varieties is circular in outline. In *D.alata*, TS of stem is circular with two wings(fig A & B). Where as in *D.bulbifera* TS of srem is 7 angular (fig C). The cuticle is generally thin in nature. The epidermis is composed of thin parenchymatous cells. Hypodermis is made up of chlorenchymatous cells. Cortex is partitioned into two; outer cortex sclerenchymatous and inner cortex parenchymatous. Vascular bundles of the stem are settled in two concentric circles. Outer and inner ring is composed of two metaxylem elements with phloem. The number of vascular bundle varies from species to species(Fig A, C & E).

The structure and position of raphides are different in each variety. In *D.alata*, raphides are only seen in pith along the parenchymatous wall (Fig A & B). Rahides are found along the cortex in *D. bulbifera* in the form of vertical needle like structure. Two different types of raphides are observed in this variety, vertical form in pith and clumped form in cortex (Fig A & C). Among the three species of *Dioscorea*, the number of raphides is more in *D.alata*.

The plants of Dioscorea produce many useful parts such as corms or rhizomes, bulbils and tubers (Islam et al, 2011). Wild varieties of Dioscorea contain many nutritional components like protein (1.5%), lipid (0.17%), crude fibre (4.1%), starch (28%), vitamins A and C and minerals such as Calcium Iron, Phosphorous ([12]Kumar et al.,2017). The antifungal activity was also reported in two species of *Dioscorea* ([13]Ezeocha *et al*., 2012). In the countries like China and Zimbabwe the tubers of Dioscorea are used as one of the constituent in folk medicine against rheumatism, diabetes, diseases associated with skin and indigestive problems (Wang et al., 2011).

Based on morphology crystals are divideed into four types crystal sand, raphide, druse, styloid and prismatic ([9]Franceschi and Horner 1980; [14]Horner and Wagner 1995; [11]Franceschi and Nakata 2005). These crystals are molded endogenously; first synthesizing oxalic acid and joined with calcium to form calcium oxalate crystals ([11]Franceschi and Nakata 2005). Calcium oxalate crystals in the form of raphides are found in two species of *D. alata*.

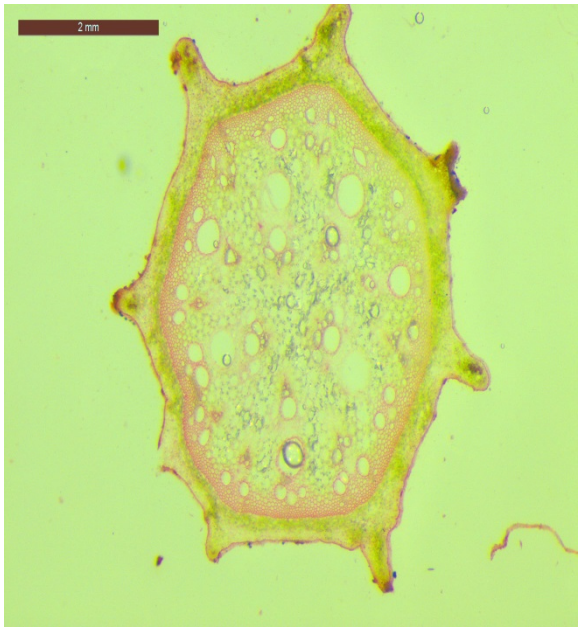

Fig A: Stem T.S of *D.alata*; Fig B: Enlarged view of stem T.S; Fig C: Stem T.S of *D.bulbifera*; Fig D: Enlarged view of stem T.S;

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