

Research Article – Plant Science

Occurrence, type and location of calcium oxalate crystals in selected medicinal plants

E. Munuswamy, V. Krishnan*, S. Amerjothy

Department of Plant biology and Plant biotechnology, Presidency College Chennai- 600005, Tamil Nadu, India

Abstract

Crystals in selected medical plants growing naturally in Place palayam reserve forest, Thiruvallur District were studied with Polarised light microscope. Four types of crystals were observed: druses, prismatic, raphide and rosettes crystal. Druses more in cortical parenchyma and ground parenchyma cells in the stem & petiole region. In contrast prismatic, raphide and rosettes present in cortical, ground, axial and phloem parenchyma in the roots and stems. The Preliminary results show the presence of four types of calcium oxalate crystals in the stems, Petiole & roots of 10 Species: *Achyranthes aspera*, *Aerva lanata*, *Atalantia monophylla*, *Bridelia Crenulata* presence of Druses crystal, *Plumeria rubra*, *Adhatoda zeylanica* presence of prismatic crystal, *Asparagus racemosus*, *Monochoria vaginalis* presence of raphide crystal and *Carica papaya* and *Carissa spinarum* presence of rosette type of crystal. These observations indicate that there is relationship between the distribution of calcium oxalate crystals and the medicinal parts of the plant and supports the view that the presence of calcium oxalate crystals may relate to the adulterants.

Key words: Calcium oxalate crystals, medicinal plants, palayam reserve forest

Introduction

Higher plants growing under natural conditions may contain crystals that consist mainly of calcium oxalate (Al – Rais, Meyers and Watson, 1971). In angiosperms calcium oxalate crystals occur in 5 major forms prisms, styloids, raphides, druses and crystal sand. (Metcalf and Chalk, 1950; Esau, 1977; Cutter 1978; Fahn, 1982). They may associated with specific tissues such as the epidermis, cortex, phloem, xylem and pith (Scott, 1941; Esau, 1977, Cutter, 1978, Francheschi and Horner, 1980, Fahn 1982) or may be randomly distributed throughout the plants. (Genua and Hillson 1985). The function of calcium oxalate in plants have been studied by many investigators: Many believed that oxalate is an end product of metabolism and that excess

amounts may be toxic to the plants (Francheschi and Horner, 1980). Kingsbury (1964) reported that calcium oxalate crystals may function as protection against foraging animals causing irritation and burning sensations to the mouth. He also reported that oxalic acid is the only organic acid of plants that is toxic to live stock under natural conditions. Fasset (1973) in his study of the toxicity of oxalates concluded that there is no hard evidences that oxalates in foods are toxic to humans. The present work is an attempt to study the specific locations of different types of calcium oxalate crystals in the selected medicinal plants. The plants are growing in Placepalayam reserve forest in Thiruvallur district located in Tamilnadu, with special reference to the possible relationship between the distribution of calcium oxalate crystals and the plant organs.

Materials and methods

Medicinal plants were selected from several families, collected during flowering season, (species used for study and their name, family,

Received: 11-10-2016; Accepted 22-12-2016; Published Online 25-12-2016

*Corresponding Author

V. Krishnan, Department of Plant biology and Plant biotechnology, Presidency College Chennai- 600005, Tamil Nadu, India

Table 1. Details of selected medicinal plants

Sl. No.	Taxon	Family	Plant part	Medicinal uses
1	<i>Achyranthes aspera</i>	Amaranthaceae	Stem	Diuretic
2	<i>Adhatoda zeylanica</i>	Acanthaceae	Root	Expectorant
3	<i>Aerva lanata</i>	Amaranthaceae	Stem	Diuretic
4	<i>Asparagus racemosus</i>	Asparagaceae	Root	Diuretic
5	<i>Atalantia monophylla</i>	Rutaceae	petiole	Asthma
6	<i>Bridelia crenulata</i>	Phyllanthaceae	Stem	rheumatic
7	<i>Carica papaya</i>	Caricaceae	Stem	anti-inflammatory
8	<i>Carissa spinarum</i>	Apocynceae	Stem	antidiuretic
9	<i>Monochoria vaginalis</i>	Pontederiaceae	Stem	Gout
10	<i>Plumeria rubra</i>	Apocynaceae	Stem	Scabies

Table 2. Occurrence and location of druses, prismatic, raphide and rosette in selected plant species

Sl. No	Species	Location of Part	Type of crystal
1	<i>Achyranthes aspera</i>	Cortical paraenchyma cells	Druse
2	<i>Adhatoda zeylanica</i>	Cortical paraenchyma cells	Prismatic
3	<i>Aerva lanata</i>	Cortical paraenchyma cells	Druse
4	<i>Asparagus racemosus</i>	Ground parenchyma cells	Raphide
5	<i>Atalantia monophylla</i>	Ground parenchyma cells	Druse
6	<i>Bridelia crenulata</i>	Cortical parenchyma cells	Druse
7	<i>Carica papaya</i>	phloem parenchyma cells	Rosette
8	<i>Carissa spinarum</i>	Axial parenchyma cells	Rosette
9	<i>Monochoria vaginalis</i>	Cortical parenchyma cells	Raphide
10	<i>Plumeria rubra</i>	Sec. Phloem	Prismatic

plant parts and medicinal uses are identified in the Table-1) and immediately preserved in FAA (Formalin – Acetic acid – Alcohol: 5 ml +5ml + 90ml of 70% Alcohol) for 24 hrs and processed by standard paraffin procedure (Berlyn and Mikshe, 1976) sections were cut 10 μ m thick and stained (Price 1967) for polarized light microscopy.

Some of the specimens were dehydrated employing Tertiary Butyl Alcohol (TBA) series as per the schedule published Sass (1940); following dehydration, the specimen were subjected to paraffin wax infiltration and cast into wax blocks. Serial section of 10-12 μ m thickness were prepared by Rotary microtome.

Histochemical determination of crystals as calcium oxalate was done on similar sections, using the procedure of Yasue (1969) and viewed with bright field light microscope. The Plant organs were processed and bleached (5% sodium hypo chlorite) and washed with water and ethanol dehydration series, then to xylol and mounted and unstained. They were examined under full and partial polarizers and captured digitally. Free hand sections made by razor blade were also observed and captured digitally.

Results

Four types of calcium oxalate crystals were identified. Druses, prismatic, raphide and rosette crystals (Figure 1-10, Table 2).

These four type of crystals were observed in the stem, petiole and roots of *Achyranthes aspera*, *Adhatoda zeylanica*, *Aerva lanata*, *Asparagus racemosus*, *Atalantia monophylla*, *Bridelia crenulata*, *Carica papaya*, *Carissa spinarum*, *Monochoria vaginalis* and *Plumeria rubra*.

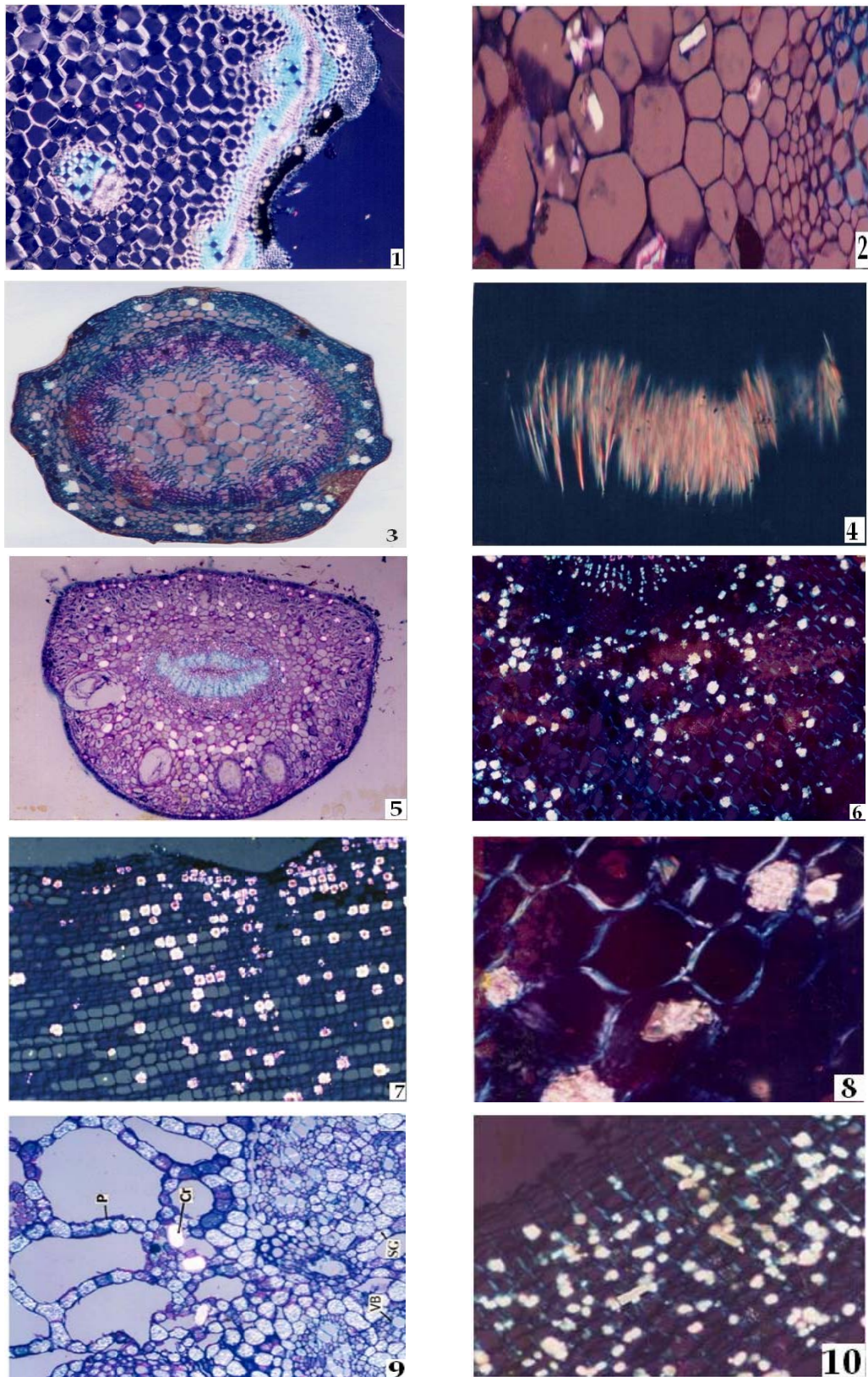
Druse crystals

Large druses occur in cortical parenchyma cells of *Achyranthes aspera*, *Aerva lanata* & *Bridelia crenulata* stem and petiole ground paraechyma cells of *Atalantia monophylla* stem.

Prismatic crystals

These crystals were found in cortical region of *Adhatoda zeylanica* root and sec. phloem in *Plumeria rubra* stem. In addition double pyramidal and rectangular calcium oxalate crystal are sporadically present in the cortical parenchyma region of *Adhatoda zeylanica* root and rhomboidal, cuboidal prismatic calcium oxalate crystal bigger in size occur in some parenchyma cells of *Plumeria rubra* stem.

Figure 1. Four type of calcium oxalate crystals *viz.* Druses, prismatic, raphide and rosette crystals



Raphide crystals

Long needle shaped calcium oxalate crystals that occurs as bundles of hundreds and thousands in the ground parenchyma tissue in *Asparagus racemosus* root and cortical parenchyma cells in *Monochoria vaginalis* stem.

Rosette

Rosette crystals are characteristic in having a central organic core from which the calcium oxalate crystals arranged in radiate manner. This type of crystal occur in phloem parenchyma cells in *Carica papaya* stem and axial parenchyma cells in *Carissa spinarum* stem. A correlation was found between occurrence of calcium oxalate crystals in the selected species are studied. All the 10 plants have well developed calcium oxalate crystals. In addition all the species found to have well – organized calcium oxalate crystals (Table 2).

Discussion

The pattern type and distribution of calcium oxalate crystal within a plant differs widely species to species; the calcium oxalate crystal may be distributed throughout the plants (root, stem, petiole, leaf, flower, fruit and seed) or they may be localized in one or more of the plant parts (North, 1967).

The stems & Petiole of *Achyranthes aspera*, *Aerva lanata*, *Atalantia monophylla* and *Bridelia crenulata* were reported in the druse type of calcium oxalate crystal present in the region of cortical parenchyma and ground parenchyma cells (Fig 1,3,5,6). The *Plumeria rubra* stem and *Adhatoda zeylanica* root are reported in prismatic type of calcium oxalate crystal were present in the region of sec. phloem and cortical parenchyma cells (Fig 2,10). *Asparagus racemosus* root *Monochoria virginals* posses a raphide type of calcium oxalate crystal present in the region of ground parenchyma and cortical parenchyma cells (Fig 4,9). The stems of *Carica papaya* and *Carissa spinarum* were devoid of well developed rosette type of calcium oxalate crystal is the new type of crystal present in the phloem and axial parenchyma cells (Fig 7,8). The observation four type of calcium oxalate present in all the 10 species plant parts. This conclusion supports the findings of Genua and Hillson (1985).

References

- Al-Rais, A.H, A.M. Myers, and L.Watson. (1971). The isolation and properties of oxalate crystals from plants. *Annals of Botany* **35**:1213 -1218.
- Berlyn, G.P and J.P Miksche (1976). *Botanical Micro technique and cyto chemistry*. OWA state university press.
- Cutter, E.G.1978. *Plant anatomy*. Part I. Cells and tissues. Oxford and IBH, New Delhi.
- Esau, K. (1977). *Anatomy of seed plants*. John wiley, New York.
- Fahn, A. (1982). *Plant natomy*. Pergamon press, New York.
- Fasset,D.W. (1973). oxalates. In committee of food and nutrition Boord, National research council (ed.), *Toxicants occurring naturally in foods*, 346-362. National academy of science, Washington, DC.
- Franceschi, V.R., and H.T Horner, JR. (1980). Calcium oxalate crystals in plants. *Botanical review* **46**:361 – 427.
- Genua, T.M., and C.J.Hillson. (1985). The occurrence, type and location of calcium oxalate crystals in the leaves of fourteen species of Araceae. *Annals of botany* **56**:351-361.
- Kingsbury, J.M. (1964). *Poisonous plants of the united states and Canada*. Prentice – Hall, Englewood diffs. NJ.
- Metcalfe, C.R, and L. Chalk. (1950). *Anatomy of the dicotyledons*. Clarendon Press, Oxford.
- North, P.M. (1967). *Poisonous plants and fungi in colour*. Blandford Press. London.
- Price, C.E.1969. A new acridine orange method for staining nuclcic acid and its application to germinating wheat seeds. *J.Micros* .960; 67-73.
- Sass, J.E. (1940). *Elements of Botanical Micro technique*, MC Graw Hill Book Co; New York.
- Scott, F.M. (1941). Distribution of calcium oxalate crystal in *Ricinus communis* in relation to tissues differentiation and presence of other ergastic substances. *Botanical Gazatte* **103**:225-246.
- Yasue, T. (1969). Histochemical identification of calcium oxalate *Acta Histochemica*. **2**:83-95.