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REVIEW

Poisoning due to ornamental plants belonging to the *Araceae* family: Review of botanical and toxicological aspects relevant for clinical practice

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Abstract. Some genera of the *Araceae* botanical family used with ornamental purposes at home pose a risk to human beings and animals; therefore accidental or voluntary exposure becomes one of the most frequent causes of household poisoning, particularly among children. It is important to highlight that only a low percentage of those patients poisoned by these plants are accurately diagnosed. This is due to the following reasons: the difficulty establishing an early diagnosis due to the enormous diversity of species and the lack of botanical knowledge leading to difficulties identifying the plant, as well as its toxic potential. Therefore, the administration of a specific treatment is delayed. This evinces the multidisciplinary character of toxicology, which requires sciences such as anthropology, botany, agronomy, ethnobotany, mycology, chemistry, etc. to identify the material concerned, as well as its active principles and main uses. The aim of this article is to highlight those botanical, biochemical and medical aspects that are relevant to understand the mechanisms through which these vegetable substances may cause harm.

Key words: *Poisoning; Toxic plants; Araceae; Ethnobotany; Ornamental plants.*

Araceae constitute a cosmopolitan family with more than 3300 species of tropical origin in South America, even in Argentina, many of which are toxic or medicinal. This family encompasses specimens such as *Dieffenbachia*, *Philodendron*, *Caladium*, *Epipremnum*, *Colocasia*, *Monstera*, *Zantedeschia*, *Alocasia*, etc. (Fig.1).[1] Their good adaptation to indoor environments makes them suitable for their use as ornamental plants in gardens and homes in almost all cities.[2] Given the exuberance of their foliage and the colourful notes of their inflorescences, together with the high distribution of these species and the fact of being within children and pets' reach, poisonings by plants (phyto-poisonings) represent a frequent reason for toxicological consultation.

The most significant aspects to be considered in poisonings due to *Araceae*, as well as their diagnosis and treatment are described below.

MATERIALS AND METHODS

A bibliographic search was carried out in specialized literature in the botanical and toxicological field. Additionally, stems from adult plants of the genus *Philodendron* (grown under controlled greenhouse conditions) were selected. For fresh observation, the "tissue scraping" or "tissue imprint" method was used. This procedure consists of collecting superficial cells from plant tissue, which allows their immediate analysis under the microscope without the need for fixation or dehydration. Transverse and longitudinal cuts were made in the middle region of the stems to ensure the uniformity of the samples. Using a sterile slide, the surface of the plant tissue was gently scraped, causing the detached cells to adhere to the slide. Subsequently, a coverslip was placed over the sample to flatten the cells and facilitate their microscopic observation.

Figure 1. Some genera of the *Araceae* family. A. *Epipremnum* (Potos). B. *Syngonium* (Arrowhead plant). C-D. *Philodendron* (horsehead philodendron). E. *Zantedeschia* (Calla) (Credits: author's own).

Observation of the samples was performed immediately under the microscope, starting with low-power objectives and progressing to higher magnifications as necessary. This method is quick and simple, eliminating the need for long preparation processes and without requiring complex equipment or special reagents. However, limitations of the method include obtaining cells only from the surface of the tissue, which may not fully reflect the internal state of the tissue. Furthermore, the quality of the sample may vary depending on the technique used and the homogeneity of the tissue. Despite these limitations, the method is particularly useful for preliminary studies and for the observation of superficial cellular structures, such as calcium oxalate crystals present in the epidermis of plant tissues.

THE *ARACEAE* FAMILY

General characteristics

Table 1 describes the scientific and vulgar names, ethnobotany, active principles and post-exposure symptoms of the most important plants of the *Araceae* family from a toxicological point of view.

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TABLE 1. Characteristics of the main species of clinical relevance.

Scientific name	Vulgar name	Ethnobotany	Active principle	Symptoms
Monstera deliciosa (Liebm.)	Swiss cheese, Adam's rib	Fruit (ripe) Leaves (wound healing ointments)	CaC_2O_4 Raphides (calcium oxalate)	Irritation of oral mucosa and gastrointestinal (GI) tract, vomiting
Dieffenbachia seguine (Jacq.)	Dieffenbachia, Leopard lily, Dumb cane	Ornamental	Raphides (calcium oxalate) Cyanogenic glycosides $C_4H_8N_2O_3$ (L-asparagine)	Intracellular crystals may cause mouth blisters and edema The eye condition includes crystalline lens damage Possible heart problems
Epipremnum pinnatum (L.)	Potos, Pothos, Devil's ivy	Ornamental	CaC_2O_4 crystals (calcium oxalate) Present in all the plant, particularly in the leaves	Ingestion: GI mucosa irritation, vomiting, diarrhoea Contact dermatitis
Zantedeschia aethiopica (L.)	Calla lily, Arum lily	Ornamental	Raphides (calcium oxalate) Cyanogenic heterosides Saponins Alkaloids	Local signs: skin,lips, mouth mucosa irritation General symptoms: vomiting, diarrhoea, mydriasis, drowsiness, coma and death
Colocasia esculenta (L.)	Elephant's ear, Taro	Rhizomes, petioles and inflorescences are consumed. Its tubers feature a high content of carbohydrates (flour) Folk medicine: treatment for abscesses, snakebitesand insect bites	CaC_2O_4 Raphides (calcium oxalate)	Serious irritation of oral and oesophageal mucosa caused by calcium oxalate crystals
Alocasia macrorrhizos (L.)	Giant elephant's ear	Ornamental Rhizomes are consumed in the Indo-Pacific region Starch-rich stem and leaves rich in minerals and vitamins A and C	CaC_2O_4 Raphides (calcium oxalate). Insoluble in water, distributed all over the plant L-asparagine	By ingestion, burning lips and mouth, glottis edema Less frequent: dysphonia and dysphagia, nausea and vomiting

Medicinal uses

In Southeast Asia, as well as in South America, *Araceae* are used for medicinal purposes. There are records of their use in propitiatory rites in the Amazon region. Contraceptive properties are often attributed to them. In the case of *Dieffenbachia* in particular, multiple medicinal uses encompassing the treatment of various diseases and conditions, such as gout, impotence, frigidity and hydropsy, among others, have been recorded. In the region of Guyana, specifically, the extract obtained from the stalks of this plant have traditionally been prescribed as part of the treatment for cutaneous leishmaniasis.[3]

Calcium oxalate crystals

The synthesis and accumulation of $Ca_2C_2O_4$ (calcium oxalate) crystals is common among some plants and is related to a biomineralization process. These crystals formed in the cytoplasm and which remain bound by a mucilaginous substance in a structure called *idioblast* (Fig. 2) may form raphides: needle-shaped crystals occurring in clusters within a cell; druses: aggregates of spherical crystals; styloids: elongated crystals with pointed or rough ends; prisms or rhombus: isolated or in groups by cell; and crystal sand: a mass of microscopic crystals.[4] In all the cases their role seems to be the elimination of excess calcium and the regulation of acidity in the cell.[5] Nevertheless, this does not seem to be their only role, since they also contribute to the way in which the plant absorbs sunlight and constitute a mechanism of defence against the threat posed by animals.

Toxicity

It is relevant to examine here the concepts of toxicity and toxic plant. As we know, a toxin is any substance that once introduced in a living organism is able to cause damage by altering its physiology, either perceptibly or not.[6] Plants can produce harm in humans, in cattle, in domestic or laboratory animals and/or in wild animals.[7] In Argentina there are few statistical records of poisoning by plants and all of them (about 0.1 to 1.3% of all toxicological consultations) generally underestimate the real number of poisoning cases.[8]

In the specific case of the genera of this family, calcium oxalate crystals act as needles, puncturing and injuring the tissues.[9] The concomitant release of vasodilator agents leads to a fast inflammatory reaction, characterised mainly by injuries:

- Mechanical in the digestive system: severe pain in the mouth and oropharyngeal region, open mouth and salivation which might be intense, congestive oral mucosa with areas of localised or generalised edema reaching the glottis, dysphagia, uneasiness, alterations in vocalisation; esophagitis, gastritis and enteritis if some sections of the plants were ingested;
- Inflammatory: some genera also have proteolytic enzymes (trypsin) featuring proinflammatory activity;
- In the skin and related structures: swollen lips, palpebral swelling, angioedema;
- In the respiratory system; larynx edema, dyspnoea;
- Eye injuries (exposure to sap): chemical conjunctivitis, corneal abrasion and, very seldom, permanent corneal opacifications.[10]

In general, chewing just one leave or any other part of the plant causes significant lesions in the mouth area, characterised by severe oropharyngeal irritation with sialorrhea which, in the most severe cases, may be followed by glottis edema, choking, dysphagia and even shock. If the plant or its content is ingested it may cause nausea, vomiting and diarrhoea. The most severe poisonings may cause peripheral paraesthesia, drowsiness, heart disturbances, hypocalcemia, renal failure, seizures, coma and death.[11, 12]

Damage mechanism

As mentioned above and according to the description in specialised literature, oxalic acid, its solutions or its alkaline salts such as CaC_2O_4, in fact widely present in this plant family, are caustic and highly irritating. Once they are in circulation they continue with kidney damage. They also produce effects on the nervous system. Alkaline oxalates, such as that of calcium, cause a rhythmical contraction of striated musculature isolated as a result of the Ca^{2+} ion sequestration from circulation, thus also depriving the blood of an essential element for coagulation and making it incoagulable.[13]

This highly irritating action may be due to the mechanical effect of calcium oxalate crystals, or in some cases to the free oxalic acid, present in the plant, as well as to the proteolytic activity added to histamine-like substances (similar to bradykinin). Furthermore, the acid absorbed when combined with calcium may precipitate forming insoluble salts and causing severe kidney and liver damage.[14]

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Treatment of poisonings

After inadvertently ingesting or being exposed to this kind of plants, intense pain and irritation may appear in the oral cavity due to the mechanical action of their crystals, but they seldom cause systemic effects. Rinsing the mouth immediately is recommended to eliminate any plant residue. In the case of children, symptomatic treatment is also important by applying ice in the affected area to relieve pain and edema in the mildest cases. Oral pain relievers may be necessary in some cases. However, special attention should be given to the evolution of more serious symptoms, such as swelling or larynx oedema, which may require additional medical interventions.[15-19]

Due to the high release of histamine and inflammatory prostaglandins, antagonists of these mediators may be

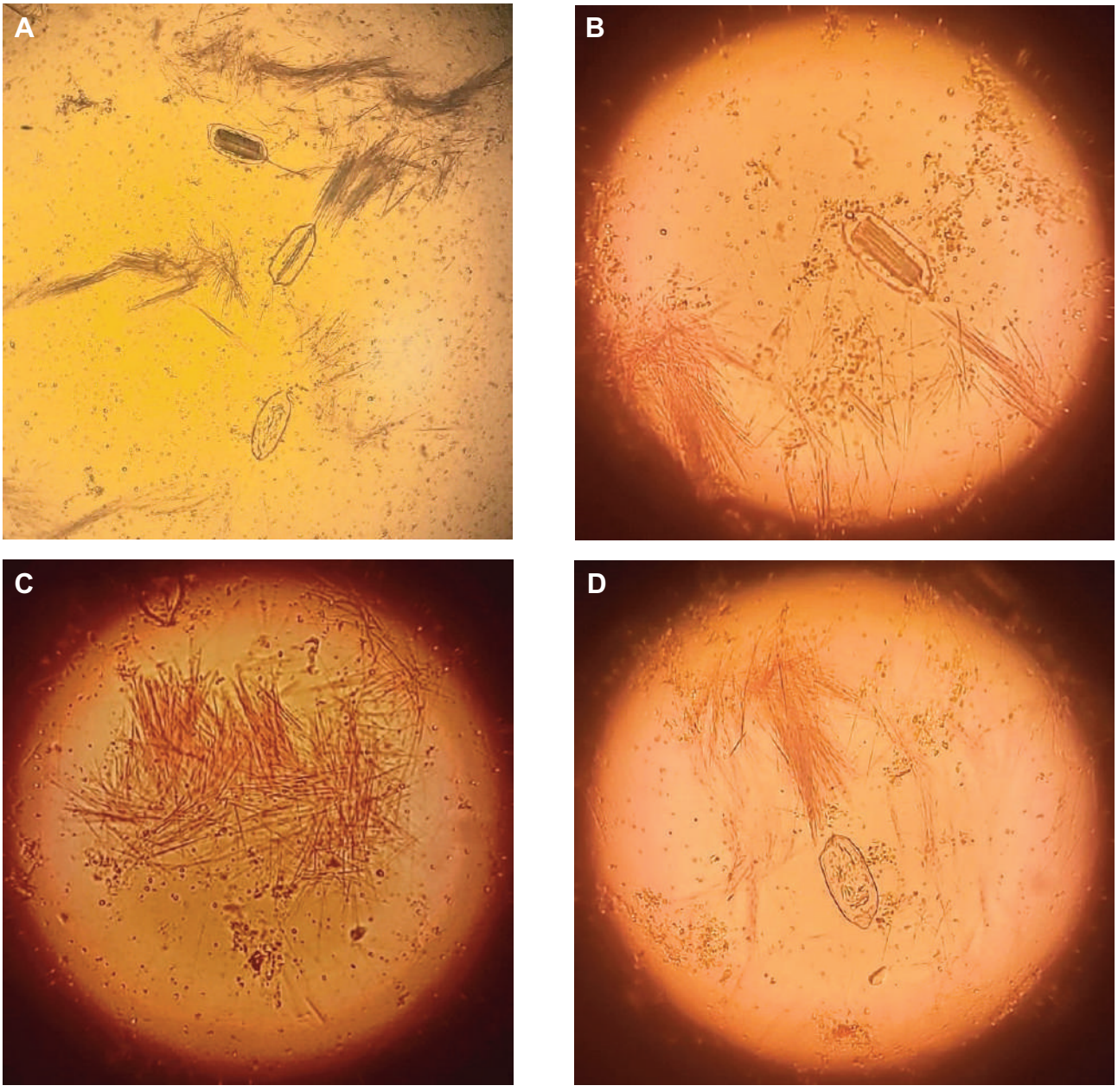

Figure 2. Crystallography. Microscopic observation (40X) of acicular crystals of calcium oxalate. Sample obtained from plant material (stalks from *Philodendron* genus), using the technique suggested by Fabré-Truhaut. A-B. Idioblasts with CaC_2O_4 crystals being released. C. Field covered by calcium oxalate crystals (raphides). D. Empty idioblast, after releasing the crystals contained inside it (Credits: author's own).

efficient at the beginning of the treatment. In particular, antihistamines are the most used. Pain relievers, parenteral opioids, corticosteroids and protection of the airways may be recommended.[20] Edema and pain usually start to decrease after 4-8 days.

In the case of eye exposure, eyes must be decontaminated by removing contact lenses and rinsing them thoroughly with saline 0.9% or water at room temperature for at least 15 minutes. Likewise, in order to clean the exposed skin, clothes and accessories should be removed, and the affected areas should be washed with abundant soap and water for 15 minutes, avoiding skin damage.[15]

Routine laboratory tests are not required. Nevertheless, in more critical situations a urine test is recommended to assess the presence of crystals in the urine, as well as to evaluate kidney function by the determination of the levels of serum urea and creatinine.[15]

DISCUSSION

The most common poisonings with plants from the *Araceae* family highlight the significance of botanical knowledge in the diagnosis and management of these cases. The difficulty in the precise identification of plant species may contribute to the lack of records of medical consultations related to poisonings by these plants. Their complex morphology and the variability in the toxicity of different species within that family emphasise the need of a close collaboration between botanists, toxicologists and healthcare providers to tackle these cases efficiently. Given the diversity of toxic compounds present in the plants, it is essential to have vast experience and specific knowledge of phytochemistry to diagnose and treat correctly those poisonings by plants. Failing to recognize the poisonings caused by specimens of this botanical family or underestimating their seriousness may have significant clinical consequences, thus the need of greater awareness and training in this field.

CONCLUSIONS

Although many plants in this family contain toxic compounds, not all of them pose a significant risk to human health due to the low chances of ingestion or contact. Therefore, it is essential to assess not only the intrinsic toxicity of the plants but also the incidence and the circumstances in which the poisonings occur. Furthermore, the relevance of the precise identification of the species of plants involved in the poisoning cases is highlighted, since different species within the *Araceae* family may have different toxicity profiles. This aspect emphasises the need of a multidisciplinary approach to guarantee a precise diagnosis and treatment for the poisonings by plants of this family.

Declaration of interest
The authors declare no conflicts of interest.

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