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ERGASTIC CRYSTALS IN IDENTIFICATION OF *COSTUS PICTUS*: A MEDICINAL SPIRAL GINGER IN HERBAL MEDICINE

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KEYWORDS

Costus pictus

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Raw drug

ABSTRACT

Present study was conducted to compare the morphological, anatomical and histochemical features of exotic species *Costus pictus* with its related *C. speciosus*, introduced in Peninsular India during the recent past. Identifying features of *C. pictus* is well documented through the present study with samples collected from different agro climatic regions along with its closely related species *C. speciosus*, which is available from the past even in wild without any characteristically reported medicinal property. The comparative study of fresh specimen shows distinctive features for identification with regard to morphological and anatomical characters at its flowering condition. The dried raw drug can be distinguished with the analysis for the presence of cuboidal solid crystal in the leaf mesophyll. Result of comparative study of leaf suggests that *C. pictus* leaves do not show the presence of cuboidal ergastic crystal in their leaf mesophyll where as *C. speciosus* leaves possess the same.

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1 Introduction

Costus pictus D. Don, (*Costus mexicanus* Liebm. *Costus igneus* Nak. *Costus mexicanus* Liebm ex Petersen or *Costus congenitus* Rowle) commonly known as fiery costus or step ladder or spiral flag or insulin plant (Jose & Reddy, 2010; Hedge et al., 2014). *C. pictus* is an introduced medicinal spiral ginger to Peninsular India and it belongs to family Costaceae. This plant is distributed along the coast from Mexico to Costa Rica and is locally known as *canaagria* or *cana de jabali* in Mexico (Remya & Daniel, 2012).

Recently this plant gains more medicinal interest due to its medicinal properties, leaves of the plant have anti-diabetic activity in humans (Mani et al., 2010; Kumudhavalli & Jaykar, 2012). The plant has very high medicinal potential and shows various pharmacological activities such as hypolipidemic (Mani et al., 2010;), diuretic effect (Meléndez-Camargo et al., 2006), anti-oxidant (Jayasri et al., 2009; Maruthappan & Sakthisree, 2010), antimicrobial (Gothandam et al., 2010; Saraswathi et al., 2010) anti-cancers (Nadumane et al., 2011) and putative activity (Manjula et al., 2012) apart from its anti diabetic activity.

C. speciosus is a native plant to India but from the beginning onward it confused with *C. pictus*. Rama Rao (1914) listed *C. speciosus* (Koenig) Smith under the family Zingiberaceae, later on many earlier Indian floras placed this genera (*Costus*) under family Zingiberaceae. Recently, Costaceae were classified as Costoideae, a subfamily or as tribe (Costeae) within Zingiberaceae. Now, genus *Costus* along with genera *Dimerocostus*, *Monocostus* and *Tapeinochilus* were transferred to the family Costaceae from the family Zingiberaceae (Nakai, 1941).

Presence of the ergastic crystals in dicotyledons and monocotyledons families was reported (generally of calcium oxalate) by many researcher in many. Forms and distribution of these crystals have taxonomic importance (Metcalf, 1960). Present study was aimed to resolve confusion between much confused species *C. pictus* and *C. speciosus*. Differentiation between these two species was purely based on the presence and form of ergastic crystal. In addition to this, conventional taxonomic and anatomic comparison was also carried out because published data on these aspects are in scanty for these species.

2 Materials and Methods

Samples were collected from five locations of south India i.e. Botanic garden, University of Kerala (Thiruvananthapuram), Kidangoor, Edayar, Palakkad and from the foot hills of Kodaikkanal. Collected plant samples were identified and authenticated by Botanical Survey of India (MH accession no: 173772), Southern Circle Herbarium, Coimbatore, Tamil Nadu, South India. Fresh as well as herbarium preserved vegetative and reproductive specimens were used for morphologic studies whereas fresh and preserved specimens were used for anatomic studies. Plant parts used for anatomic studies include adventitious roots, aerial shoot, underground rhizome and foliar leaves. Differentiations between these two species are basically based on the ergastic crystals by anatomical study.

3 Results

Various morphological characters observed from fresh vegetative and reproductive structures of *C. pictus* and *C. speciosus* are summarized in table 1.

Table 1 Comparative morphological feature of *C. pictus* and *C. speciosus*

Character	<i>C. pictus</i> *	<i>C. speciosus</i> *
Plant height at flowering stage	35 – 240 cm	25 – 95cm
Spiraling nature of stem	Minimum towards tip	Prominent towards tip
Adventitious buds on aerial stem	Present (3 – 18)	Absent
Number of leaves/branch	18 – 36	7 – 18
Length of longest leaf	18 – 23 cm	12.5 – 27 cm
Width of largest leaf	6.8 – 8.3 cm	3.89 – 10.6 cm
Size of Mature Rhizome	Length 42cm & 3.5cm thick	Length 33cm & 2.8cm thick
Flower bud	Yellow with rounded tip	Flesh colored with pointed tip
Flower color (Figure 1 & 2)	Lemon yellow	Creamy white
Flower size	5.1 cm – 6.9 cm	5.1 cm – 8.1 cm
Labellum	Lemon yellow with reddish markings	Creamy white
Labellum size	5.5 cm x 4.5 cm	7.6 cm x 6.8 cm
Fruits	Not reported in Peninsular India	Loculicidal capsule with persistent calyx
Seeds	Not reported in Peninsular India	Black with white arils and angular end
Means of vegetative propagation	Aerial shoot cuttings, adventitious buds and rhizomes	Rhizomes

*All the values given in tables are means of sample collected from all study sites

Table 2 Comparative anatomic features of *C. pictus* and *C. speciosus*

Character	<i>C. pictus</i> *	<i>C. speciosus</i> *
Calcium oxalate crystals	Present in all parts except leaves	Present in all parts
Metaxylem in root	Rounded	Bigger with trigonous outline
Crystals in leaf	Absent	Cuboidal in outline

*All the values given in tables are means of sample collected from all study sites

Table 3 Comparative herbarium features of *C. pictus* and *C. speciosus*

Character	<i>C. pictus</i>	<i>C. speciosus</i>
Leaf texture	Smooth surface	Coarse surface
Appearance	Smooth upper and lower surface	Distinct upper and lower surface

Sections cutting of fresh and preserved specimens of leaves, aerial shoot, rhizomes and adventitious roots were examined microscopically and all the reported differences are summarized in table 2. The presence of calcium oxalate (ergastic) crystals is more consistent in the aerial shoot and rhizomes (Figure 3-10).

Herbarium specimens of both the samples were examined to find the differences and the results obtained are presented in table 3. The herbarium specimens of *C. pictus* prepared was authenticated by Botanical Survey of India and deposited with accession no 173772 Southern Circle Herbarium, Coimbatore, Tamil Nadu, South India. Voucher specimens of herbarium are maintained at the research center.

Figure 1 Inflorescence – *Costus pictus* Figure 2 Inflorescence – *Costus speciosus* Figure 3 T.S. of aerial stem *C. pictus* Figure 4 Portion of Rhizome *C. pictus*

4 Discussions and Conclusion

Tropics are blessed with numerable plants which are of multifarious use. The combined effect of plant introduction and cultivation has largely accelerated the interest of scientists and industrialists to focus on herbal medicine and other economic products (Nayagam, 2015B). Published evidence for the presence of *C. speciosus* in South Indian land is available since 17th century (Rheede, 1692) but, *C. pictus* is a recently introduced species (Jose & Reddy 2010; Hedge et al., 2014). Correct taxonomic identification is most important before proceeding to any analytical procedure and utilization. Comparative approach on morphological and anatomical features provides distinguishable features (Sabu, 2006; Nayagam, 2015A) but most of the reliable distinguishing

characters are with respect to reproductive morphology (Figure 1 and 2)(Table 1). Morphological features of vegetative parts with qualitative value varies with the localities with respect to growing regions and cultivars are considered. Since the flowers of the studied species are produced seasonally and the economically important part is leaves, so identification based on reliable anatomical characteristic may be useful for making differentiation in these two species and help in the identification of raw drug. Ergastic crystals can be an important diagnostic tool for the identification of such economically important species (Metcalf, 1960). Presence of characteristic cuboidal ergastic crystal in the leaves of several plant species including *C. speciosus* has been well reported (Wallis, 2005; Kokate et al., 2010).

Figure 5 T.S. of *C. speciosus* Rhizome – outer cortex

Figure 6 T.S. of *C. speciosus* Rhizome

Figure 7 T.S. of Adventitious root *C. pictus*

Figure 8 T.S. of *C. speciosus* root

Figure 9 T.S. of *Costus pictus* lamina Figure 10 T.S. of *Costus speciosus* Leaf with Characteristically shaped Crystals

Since the cuboidal crystals of calcium oxalate are present in the mesophyll cells of *C. speciosus* and these are not reported from the mesophyll cell of *C. pictus* leaves, it can be become a consistent and easily identifiable characteristic between these two species. The presence of oxalate crystals is characteristic in aerial shoot and rhizome, where size of crystals found smaller towards the tip of shoot whereas size of crystals towards is bigger in size. Rhizome possesses crystals with comparatively larger size in *C. pictus* (Figure 4). The cortex of rhizome in *C. speciosus* is characterized with several layers of compressed cells (Figure 5) followed by cells with numerous ovoid crystals (Figure 4). So the presence of ergastic crystals from various plant parts, its size and structure is an important taxonomic key for the making difference between medicinally important exotic species *C. pictus* and native *C. speciosus*.

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Conflict of Interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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