

Keys to the Cultivars of Keladi (*Colocasia esculenta* — Araceae) in Peninsular Malaysia

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Abstract

Colocasia esculenta (Araceae), the Keladi or *taro*, is an ancient staple food crop of the Asian and Oceanic Pacific populations. In Peninsular Malaysia, collections have reached 50 cultivars but only two of them are commercially cultivated. Confusion exists in the identification of these cultivars, which is attributed to loose usage of vernacular names. In this study a key to these cultivars is presented, one which has been worked out from plants grown *in situ* and replanted in experimental plots. Only stable morphological and behavioural characteristics have been used in differentiating the cultivars.

Introduction

The Araceae, a family of about 115 genera and over 2000 species, is of worldwide distribution, but 92% of the species are native to the Asiatic and American tropics. The centres of greatest diversity are Brazil and the Indo-Malaysian region (Watt, 1889; Burkill, 1935; Chang, 1958; Keleny, 1962; Leon, 1976). In Peninsular Malaysia alone there are some 23 genera and 120 species (Henderson, 1954).

The family is often an important component of tropical forests especially the rainforest. There is considerable diversity of form in the family, as well as evident adaptation to several rather different habitats. Some genera have become well-known in cultivation either as ornamental plants, such as *Aglonema*, *Dieffenbachia*, *Caladium*, *Scindapsus*, *Syngonium*, *Philodendron*, *Raphidophora*, and genera with colourful inflorescences such as *Anthurium*, *Spathiphyllum*, *Typhonium*, and *Zantedeschia* or as useful plants providing food, occasionally the fruit (as *Monstera*) or, more usually, the enlarged subterranean storage organs or corms (*Alocasia*, *Amorphophallus*, *Colocasia*, *Cyrtosperma*, and *Xanthosoma*). One genus, *Pistia*, has become highly specialized as a floating aquatic plant.

The Araceae are divided into eight subfamilies on morphological and anatomical grounds (Engler & Prantl, 1889; Engler & Krause, 1920). Each subfamily is in turn subdivided into tribes. The genera with edible subterranean corms are in two subfamilies, *Lasioideae* and *Colocasioideae*. The first of these consists of terrestrial or paludose shrubs with sagittate, multiparted leaves with reticulate venation. They have either bisexual or unisexual flowers, anatropous ovules, and ex-endospermous seeds. The fibrovascular bundles have superposed simple laticiferous cells. *Cyrtosperma* and *Amorphophallus* are included in the *Lasioideae*.

The *Colocasioideae* contains the useful genera *Colocasia*, *Alocasia*, and *Xanthosoma*. The first two are Asiatic, the last is an American genus. These plants are usually found in wet or swampy ground, have spirally arranged long-petiolate leaves with a sagittate lamina or with a pair of posterior lobes, and with reticulate venation. The petiole is peltately attached to the lamina. The flowers are unisexual and the plants are monoecious, the ovules anatropous or orthotropous. The laticiferous cells are fused, anastomosing in the fibrovascular bundles.

The genus *Colocasia* is one of the most important useful genera. There are seven species, according to Engler & Prantl (1889), all indigenous in Asia (Bentham

& Hooker, 1883; Conner, 1908). The best known species, *Colocasia esculenta*, was first described as *Arum esculentum* by Linnaeus in 1775 (Hill, 1952), who also described simultaneously *Arum colocasia*. Schott established the genus *Colocasia* in 1832 and renamed Linnaeus's species as *C. antiquorum* and *C. esculenta*. While some disagreement remains over these "species" many botanists now recognize one species, though some divide this into subspecies or varieties (Purseglove, 1975). For example, *Colocasia esculenta* may be regarded as consisting of two varieties, var. *esculenta* (syn. var. *typica* A. F. Hill) and var. *antiquorum* (Schott) Hubb. & Rehd.

At the cultivar level, however, there are many more entities, and there has never been a complete classification of the cultivars. Since *Colocasia* plants are normally propagated vegetatively, each region or country tends to have and perpetuate its own "forms" of which at least 1000 are thought to exist (Kay, 1973).

Owing to the plasticity as well as the morphological and behavioural diversity of these plants, and to a prior lack of collections and descriptions, there are very few adequate references to permit the accurate identification of cultivars.

Cytological and karyological studies of the Keladi have been carried out to some extent but, although several workers have been involved, their findings are inconclusive (Ito, 1942; Rao, 1947; Delay, 1951; Yen & Wheeler, 1968; Marchant, 1971).

Local Cultivars of *Colocasia esculenta*

In Peninsular Malaysia the common name "Keladi" refers not only to *Colocasia* but to all similar tuber- and corm-bearing plants including species of *Alocasia*, *Amorphophallus*, and even unrelated plants such as *Eichhornia crassipes* (Water Hyacinth; Watson, 1896; Burkill 1935; Furtado 1937, 1940). However, in the present paper, "Keladi" is used strictly for referring to *Colocasia*.

Cultivars are usually provided with vernacular names and they are propagated by vegetative means; hence each is a clone (Allen 1940; Chee and Low 1976; Ghani 1979). The cultivar name may be descriptive or not, and may be known only regionally.

Though local names have proved helpful, much confusion exists because of the numerous cultivars, their diversity and plasticity. It is believed that strict definitions and careful use of the cultivar names is worth achieving, thus permitting better communication between growers and research workers.

Collection and Identification

All plants located during collection trips were first observed *in situ*, and descriptions of them drawn up. Later they were transferred to prepared experimental plots. Repeated visits were made to the original collection sites to observe growth, and these observations formed a basis for comparison with similar ones made on the plot-grown plants.

Identifications were made using reference specimens preserved in the Herbarium of the Botanic Gardens, Singapore (SING). From these, and primarily from the living plants, the identification key was prepared. Characters were tested for consistency and reliability over a four-year period of study.

A model for the key and characteristics used has been the classic study by Whitney (Whitney *et al.*, 1939) on Hawaiian taro varieties. Characteristics of the developmental stages of the crop, descriptions of the inflorescences (where available) and longevity have all been utilised.

The crop cycle of the cultivars is important in identifying the maturity phase i.e. the mid-crop period. At this stage the colour and markings of the leaf lamina, petioles, corm flesh, leaf shape and size, number, length and colour of stolons and rhizome are stable characters for identification purposes.

During the first few months of growth, while the plant attains height and enlargement of corm size, and produces new leaves in increasing numbers, the morphological characters are in a state of flux. At mid-crop, maximum plant height, leaf number and leaf size are attained, after which there is a decline, until at harvest when leaf number is reduced to 2-3 and plant height reaches between 30 and 40 cm.

Corms of the Keladi cultivars observed over the 4-year experimental period exhibited consistent differences in configuration, which are useful in grouping the cultivars *viz.*, corm occurring singly and surrounded by cormels of the same size or different sizes, shapes of branching corms, and presence or absence of stolons.

These characters have been used to initiate a preliminary key for identifying the Malaysian Keladi cultivars. Ongoing research and observations could be used to update useful characters and contribute towards a better key.

Grouping of Cultivars

GROUP I. Crop cycle 9 to 11 months: — plants tall, 80-110 cm; petioles upright or spreading, thick; leaves sagittate.

Subgroup Ia:— corms single, cylindrical with ends tapered; plants producing stolons.

Subgroup Ib: — corms single, cylindrical or globose, surrounded by cormels.

GROUP II. Crop cycle 6 to 8 months: — plant-height medium, 50-70 cm; petioles upright or spreading, slender, leaves sagittate or cordate.

Subgroup IIa:— parent corm globose, with stolons producing plants close to the parent corm, giving rise to "thick" clumps of plants of uniform height. Stolon plants produce 10-12 smaller globose cormels closely arranged around the parent corm.

Subgroup IIb:— corms cylindrical, single, without stolons.

GROUP III. Crop cycle 5-6 months: — plants short, 30-50 cm tall, petioles slender, outspreading, leaves small and cordate.

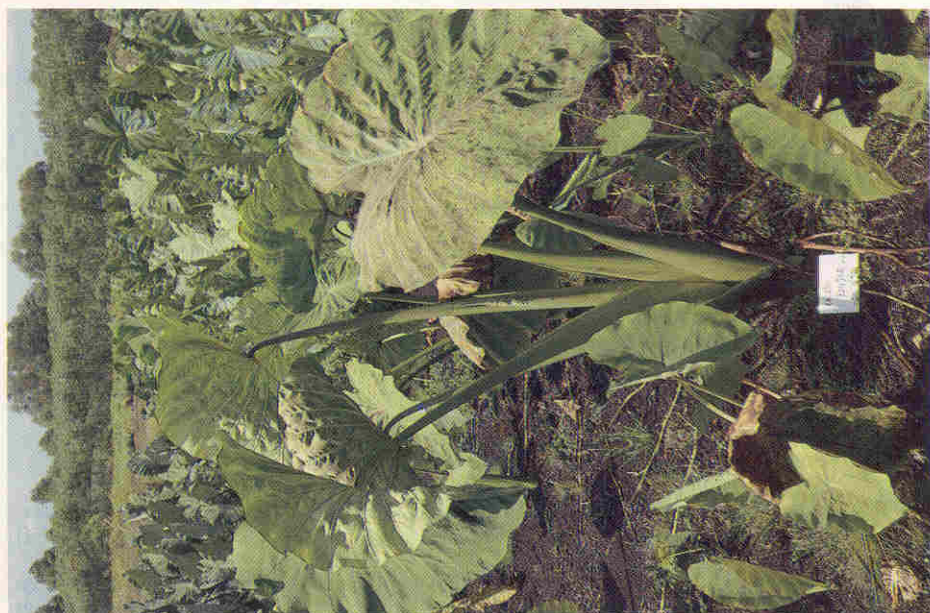
Subgroup IIIa:— parent corm single, not branching, surrounded by 6-8 cormels of similar size and shape.

Subgroup IIIb:— corm branching, appearing like clump of 6-8 corms.

GROUP IV. Crop cycle indefinite:— leaves and petioles not acrid (edible). Corms reduced (rhizomatous), acrid (inedible).



Plates 1 & 2. Vegetative characters of some cultivars of *Colocasia esculenta*. 1, left, Keladi cina; 2, right, Keladi udang.



Plates 3 & 4. Vegetative characters of some cultivars of *Colocasia esculenta*. 3, left, Keladi minjak, 4, right, Keladi banjar.

KEY TO PENINSULAR MALAYSIAN Keladi CULTIVARS

Key to Groups I — IV

- 1. Crop cycle 5-6 months GROUP III
- 1' Crop cycle longer or indefinite
 - 2. Crop cycle 6-8 months GROUP II
 - 2' Crop cycle longer or indefinite
 - 3. Crop cycle 9-11 months GROUP I
 - 3' Crop cycle indefinite GROUP IV

Key to Keladi Cultivars of Group I

- 1. Parent corms 20-24 cm long, 10-12 cm wide, single, cylindrical, tapered at both ends, producing numerous (8-10) stolons
 - 2. Leaf lamina not variegated or mottled over entire surface in white, yellow and green
 - 3. Main veins on the under-surface of lamina not purplish black. Lamina in shades of green
 - 4. Laminar sinus purplish black-pink, the colour extending only to the petiole, the piko* green, lamina sagittate Keladi cina (Plate 1)
 - 4' Laminar sinus deep red, the colour extending to all main veins on lower surface, the piko reddish green, lamina not sagittate Keladi udang (Plate 2)
 - 3' Main veins on under-surface purplish black Keladi batang hitam
 - 2' Leaf lamina variegated or mottled in white, yellow and green Keladi air
- 1' Parent corms 15-18 cm long, 8-9 cm wide, single, cylindrical, surrounded by 5-7 smaller cormels, without stolons at maturity
 - 5. Lamina with upper surface glaucous dark green and lower surface green; veins and undulating margin purplish red Keladi nibong merah
 - 5' Lamina with upper and lower surface and margin otherwise
 - 6. Lamina with upper surface waxy green and lower surface light green; veins conspicuously ridged, white to cream Keladi minyak (Plate 3)
 - 6' Lamina surfaces not as above and veins not ridged
 - 7. Petioles purplish black throughout except for the white base Keladi serakit hitam
 - 7' Petioles not entirely purplish-black
 - 8. Petioles pale green throughout except for the greenish-yellow base Keladi batang hijau
 - 8' Petioles otherwise
 - 9' Corm flesh yellow, flecked with pale brown fibres Keladi serakit putih
 - 9' Corm flesh creamy white, flecked with brownish yellow fibres Keladi banjar (Plate 4)

*Centre of the leaf lamina

Key to Keladi Cultivars of Group II

1. Parent corm globose, 10 cm diameter, surrounded by cormels (6-8) of same size
 2. Leaf cordate and pendant
 3. Lamina: upper surface wrinkled, piko green Keladi cincang wangi
 - 3' Lamina: upper surface not wrinkled, piko black splashed Keladi pinang (Plate 5)
 - 2' Leaf not cordate and not pendant, lamina broad sagittate and cupped Keladi putih
- 1' Parent corm not globose, 8-10 cm diameter, 15-18 cm long; tapered at both ends, surrounded by 6-8 smaller cormels or stolons
 4. Lamina: upper surface glaucous dark green; margin undulating and blackish purple; veins on the lower surface purplish red Keladi bantan (Plate 6)
 - 4' Lamina: surfaces, margin and veins not as above
 5. Petiole reddish purple and with green longitudinal stripes throughout except for the purplish base Keladi songket ungu
 - 5' Petiole not reddish purple
 6. Petiole creamy white with green longitudinal stripes Keladi songket hijau
 - 6' Petiole otherwise
 7. Corm flesh lilac purple, without fibres Keladi dara
 - 7' Corm flesh reddish orange, with brown fibres Keladi kelapa

Key to Keladi Cultivars of Group III

1. Parent corm non-branching, cormels small, 10 cm diameter, globose (or cylindrical, 10 cm wide, 10-12 cm long)
 2. Petiole light green with dark green striations
 3. Petiole base and collar ring yellow or brown Keladi lilin
 - 3' Petiole base and collar ring pinkish purple Keladi dara
 - 2' Petiole not entirely green, with purple and white striations Keladi tongsan
- 1' Parent corm branching at apex Keladi peladang

Key to Keladi Cultivars of Group IV

1. Tall plants 80-100 cm high; rhizome underground
 2. Petiole greenish yellow throughout, with the basal zone white
 3. Leaf sagittate, the upper surface wrinkled Keladi huma
 - 3' Leaf not sagittate, the upper surface smooth, glossy Keladi air
 - 2' Petiole colour not as above, but with purplish green streaks; petiole-lamina junction pinkish Keladi belang hijau
- 1' Shorter plants, less than 80 cm high; rhizome underground, acrid
 4. Petiole with alternate bands of blackish green and light green
 5. Leaf narrowly sagittate; lamina margin undulating Keladi hutan
 - 5' Leaf not narrowly sagittate; lamina margin smooth Keladi liar



Plates 5 & 6. Vegetative characters of some cultivars of *Colocasia esculenta* 5, left, Keladi pinang; 6, right Keladi bantan.

- 4' Petiole without markings, light green throughout, the basal zone white and the collar ring dark green Keladi kubis

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