



## A review of taro plant *Colocasia esculenta* (L.), including its morphology, phytochemistry, ethnomedical applications, and pharmacological activities

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### Abstract

*Colocasia esculenta* Linn. Belongs to family Araceae which is also referred as alupam (Sanskrit), aravi (Hindi), and taro (English). It's a tall, perennial herbaceous plant that grows all over India. Taro has numerous culinary applications, including as a stabilizer, emulsifier, fat substitute, and filling agent, taro starch (70–80%) is regarded as the least expensive component for the food business. Starch is created when photosynthesis produces too much glucose and is used by plants as a food source. When starch is present and certain enzymes are drawn out of the cell to feed the plant tissues, starch breaks down into its monosaccharide units (glucose) as needed. *Colocasia* plants are edible arums with enormous leaves and one or more starchy food-storing stems (corms) in their subterranean stems. Taro corms and leaves are rich in vitamin C and vitamin B complex (riboflavin, thiamin, and niacin), which are essential nutrients for human nutrition. Roots and tubers contain significant levels of dietary fiber, but they are deficient in most other vitamins. Roots and tubers contain significant levels of dietary fiber, but they are deficient in most other vitamins. Cooked taro leaves include beta carotene, iron, and folic acid, which all aid in the prevention of anemia. It shows Antimicrobial activity.

**Keywords:** *Colocasia esculenta*, taro, traditional medicine systems, starch, vitamin, minerals, paracytic stomata, hydroalcoholic extract

### Introduction

It is widely accepted that traditional medical systems have always been crucial in supplying the world's healthcare needs. They are doing so now and will continue to be important players in the future. Indian Systems of Medicine refers to the medical systems that are thought to have originated in India or that were brought to India from other nations and integrated into Indian culture. India has the rare advantage of having six accepted medical systems in this field. They are yoga, naturopathy, homoeopathy, Siddha, Unani, and Ayurveda<sup>[1]</sup>.

Since ancient times, plants have been used by humans to improve their quality of life and maintain their health. They are also important sources of flavoring, beverages, medications, cosmetics, and dyes. The idea behind the rise in popularity of herbal therapy in recent years is that certain plants have inherent properties that can improve health and treat disease. As a result, there is a greater emphasis on plant study worldwide, and a wealth of data indicates that medicinal plants that are utilized in a variety of traditional systems have great potential<sup>[2]</sup>.

Numerous herbs are mostly used to treat conditions related to the liver, central nervous system (CNS), digestive system, metabolism, and cardiovascular system. They can be helpful as a medication or supplement in the treatment or management of a variety of disorders due to their ability to have a significant therapeutic effect. A broad range of biological actions have been shown by herbal medications, medicinal plants, and the extracts and isolated chemicals from these sources. Researchers worldwide are still interested in ethnopharmacological studies on these herbs or other exotic plants used for medical purposes<sup>[3]</sup>.

One such plant is *Colocasia esculenta* Linn, which is also referred to as alupam (Sanskrit), aravi (Hindi), and taro (English). It's a tall, perennial herbaceous plant that grows all over India. Taro has numerous culinary applications, including as a stabilizer, emulsifier, fat substitute, and filling agent, taro starch (70–80%) is regarded as the least expensive component for the food business. Starch is created when photosynthesis produces too much glucose and is used by plants as a food source. When starch is present and certain enzymes are drawn out of the cell to feed the plant tissues, starch breaks down into its monosaccharide units (glucose) as needed. *Colocasia* plants are edible arums with enormous leaves and one or more starchy food-storing stems (corms) in their subterranean stems<sup>[4]</sup>.

### Plant profile

*Colocasia esculenta* Linn. (Araceae) is also known as *Arum esculentum* L. or *Colocasia antiquorum* Schott<sup>[5]</sup>. Geographically, it grows throughout India and is farmed over the world<sup>[6,7]</sup>.

### Vernacular Names<sup>[8]</sup>

**English:** Taro

**Bengali:** Alti Kachu, Kachu

**Gujarati:** Aalavi, Patarveliya

**Hindi:** Arvi, Kachalu Kannada: Kesavedantu

**Malayalam:** Chempu, Madantha, Chempakizhna

**Marathi:** Alluu

**Sanskrit:** Alupam, Alukam

**Tamil:** Sempu

**Taxonomical classification** [8, 9]

**Kingdom:** Plantae

**Subkingdom:** Tracheobionta

**Superdivision:** Spermatophytes

**Division:** Magnoliophyta

**Class:** Liliopsida

**Subclass:** Arecidae

**Order:** Alismatales

**Family:** Araceae-Arums

**Genus:** *Colocasia schott*

**Species:** *Colocasia esculenta* (L.)

**Geographical distribution** [6, 7]

It appears to have originated in Malaysia. From India, it was shipped further west to ancient Egypt, Taro root is known as arrow root in Kenya. It is a wild plant that is cultivated in hotter portions of India and Sri Lanka. Plants of this species are more prevalent in Japan and China. It is grown in all hot countries.

**Habitat** [7, 12]

It was discovered that magnesium had a notably positive impact on taroleaf output. The utilization of green leaf mulch and a spacing of 60X45 cm enhanced yield greatly under Kerala's agroclimatic conditions, while leaving the cormels' starch and oxalate content unaffected. The cormels' protein content rose with the use of leaf mulch. Using Dadap (*Erythrina* spp.) and *Panicum maximum* Linn. as soil mulches was proven to boost taro growth and yield; however, the former proved to be more successful than the latter. It can be found in India at an elevation of 2,440 meters in damp, shaded areas of woods.

**Morphology** [12]

- The tall plant *Colocasia esculenta* Linn. is both flowering and leafing at the same time. It can be tuberous or have a thick, short caudex.
- Simple leaves have an ovate-cordate, sagittate-cordate, or peltate lamina, as well as a robust petiole.
- Appendix substantially shorter than the inflorescence, spadix shorter than the petiole and much shorter than the spathe.
- Petiole erect, up to 1.2 m long, seldom longer, with a triangular sinus cut one-third to half way to the petiole; beneath, it is usually whiter or tinted, but not always glaucous.
- The surface above is dull and unpolished.

- Lamina is narrowly lanceolate, acuminate, convolute, never widely open, and curves slightly backwards in flower.
- The spathe is pale yellow and measures 15 to 35 cm in length. The tube is greenish and oblong.
- Short female inflorescences and lengthy, cylindrical male inflorescences are typically separated by neuters.
- Appendix: upright, subulate, abbreviate, elongate-conical, or fusiform. 3–6 androus male flowers.
- Ovary oval or oblong, one-locular; ovules numerous or many, biseriate; style 0 short at first, 0 later; stigma depressed-capitate, very short-lived, 3-5 sulcate. Female flowers 3–4 gynous.
- Berries: numerous seeds, oblong or obconic. Sulcate, oblong seeds. much albumen; embryo axile.
- Stem above ground zero, or much enlarged at the base of the leaf sheaths, originating from a firm, tapering rhizome, or, in cultivated species, a tuberous rhizome occasionally with suckers and stolons.
- Compared to the spathe, the spadix is substantially shorter. As long as the sterile male inflorescence, the female inflorescence.
- Appendix much shorter than inflorescence; stigma discoid; style quite short.



**Fig 1:** *Colocasia esculenta* Linn. [25]



**Fig 2:** *Colocasia esculenta* Linn. [26]

**Microscopy** <sup>[13]</sup>

Histological features of *C. esculenta* leaf are summarized below

**Epidermis:** The upper epidermis of a leaf is composed of a single layer of spherical to polygonal cells with a cutinized upper surface. When chlorophyll is present in epidermal cells, the morphologies of the cells are wavy and range from straight to slightly beaded anticlinal walls. A single layer of polygonal cells with straight to slightly beaded anticlinal walls is visible in the lower epidermis. Additionally visible in the lower epidermis are papillae and paracytic stomata.

**Mesophyll:** Mesophyll differentiates into spongy parenchyma and palisade, displaying a dorsiventral layout. Palisade cells contain phenolic chemicals and chlorophyll.

**Spongy parenchyma:** The leaf is composed of parenchymatous cells, which range in size and form and have a thickness of roughly 7-9 cells. It also exhibits the presence of vacuoles. There are sporadic vascular components scattered throughout. Compound-type starch grains, which are simple, spherical, with central centers and less noticeable striations, fill most of the cells.

**System of conducting tissue:** Parenchymatous bundle layer. Sclerenchymatous bundle sheath, which reaches to the upper, lower, or both epidermis, envelops the bigger

vascular bundles. There are simple vascular bundles present, and there is only one around each one.

**Chemical composition**

Like other root crops, taro corms have a high carbohydrate content but a low fat and protein content. Its potassium content is high and its phosphorus value is mild. The mineral-rich taro corm's small starch granules help with better digestion and absorption, which raises the nutritional content's bioavailability. Because taro contains symbiotic soil bacteria in both the root and rhizome, it has a higher protein content than other root crops. These bacteria increase the amount of nitrogen in the leaf and corm and fix microorganisms in the air <sup>[8, 9]</sup>. Additionally, bacteria are used as a plant growth enhancer since they release growth hormone into the root and distribute it throughout the entire plant. The free-living nature of these soil bacteria helps the taro crop grow in a range of ecological and environmental conditions <sup>[10]</sup>. These characteristics are important for the environment and the economy. Taro corms and leaves are rich in vitamin C and vitamin B complex (riboflavin, thiamin, and niacin), which are essential nutrients for human nutrition. Roots and tubers contain significant levels of dietary fiber, but they are deficient in most other vitamins. Roots and tubers contain significant levels of dietary fiber, but they are deficient in most other vitamins. Cooked taro leaves include beta carotene, iron, and folic acid, which all aid in the prevention of anemia <sup>[11]</sup>.

**Phytochemistry** <sup>[12]</sup>**Table 1:** Phytochemistry of plant *Colocasia esculenta* L

Part of plant	Chemical constituent
leaves	Calcium oxalate, fibers, minerals (calcium phosphorus, etc.), and starch, vitamin A, B, C, flavones, apigenin, Triterpenoids and Flavonoids are Luteolin, Orientin, Iso-orientin, Iso-vitexin, Vicenin-2, Orientin 7-O-glucoside, Iso-vitexin 3'-O-glucoside, Vitexin X'' -O-glucoside, Luteolin 7-O-glucoside.
Tubers	Starch(73-76%), Natural polysaccharide (56% Natural sugars, 40% Anionic components) Oxalate, Amino acids (13 to 23%), Nitrogen content (0.33 to 1.35%), Lipid (0.23 to 0.52%), Phosphate monoester derivatives (0.017 to 0.025%), Dihydroxysterols, $\beta$ -sitosterol, Stigmasterol, Nonacosane, Cyaniding 3-glucoside, Aliphatic compounds(Tetracos-20-en-1, 18-diol 25-methyl triacont-10-one Octacos-10-en-1, 12-diol Pentatriacont-1, 7-dien-12-ol 25-methyl-tritriacont-2-en-1, 9, 11-triol), Octadecenoic acid, Globulins accounts for around 80% of the total tuber proteins. Enzymes(Lipoxygenase, Lipid hydro peroxide-converting enzyme)
Petiole	Anthocyanins (3.29%)

**Table 2:** Nutritional profile of *Colocasia esculenta*L. <sup>[12]</sup>

Nutrients (100 g/dry weight) Crude <i>C. esculenta</i>	Nutrients (100 g/dry weight) Crude <i>C. esculenta</i>
Water	70.64
Energy	112 kcal
Carbohydrates	26.46 g
Protein	1.5 g
Total fat	0.20 g
Dietary Fibers	4.1 g
Ash	1.2 g
Vitamins	
Niacin	0.600 mg
Riboflavin	0.025 mg
Thiamine	0.095 mg
Folates	0.022 mg
Vitamin C	4.5 mg
Vitamin E	2.38 mg
Minerals	
Calcium	43 mg
Copper	0.172mg
Magnesium	33 mg
Iron	0.550 mg

Zinc	0.230 mg
Manganese	0.383 mg
Sodium	11 mg
Potassium	591 mg

### Therapeutic Uses

Aerial parts & Whole plant parts *viz.* Leaves, stem, and tubers show different medicinal properties. The entire plant used as an antimicrobial, anti-hepatotoxic, anti-diabetic, anti-lipid peroxidative action, anti-metastatic, anti-fungal, anti-inflammatory [13, 14]. It is also used to prevent malignancies of the mouth and lungs. A leaf juice hydroalcoholic extract used as a sedative, smooth muscle relaxant, anxiolytic, and antidepressant. Body aches and external baldness are treated with corm juice. Internally, it functions as a galactagogue, laxative, demulcent, anodyne, and anodyne. It is also used to treat piles and portal system congestion. Styptic in nature, the pressed juice of the petiole can be applied to stop arterial bleeding. The peel's infusion is used to treat diarrhea, raise body weight, and stop asthmatics from secreting too much phlegm. Arterial bleeding can be stopped by applying the styptic squeezed juice of the *C. esculenta* petiole. In addition to being used as

a stimulant and rubefacient, it is also used to treat internal hemorrhages and earaches. The starch and the gum obtained from the tubers can be commercially made use of in pharmaceutical industries in form of binder, matrix forming agent, thickening agent etc. Leaf juice has astringent, expectorant, appetizer, stimulant, and otalgia properties. Alopecia cases are treated with corm juice (baldness). Corms of *C. esculenta* were employed as a body discomfort cure. When there is swelling of the lymph nodes and irritated glands, the juice taken from the petioles with salt is utilized as an absorbent. Mucilage contained in cooked vegetables makes them a useful nervine tonic. Peel decoction is used as a traditional medicine to treat diarrhea, raise body weight, and stop asthmatic patients from secreting too much phlegm. In cases of piles and portal system congestion, it is used as a laxative, demulcent, anodyne, and galactagogue [15, 16].

**Table 3:** Pharmacological activities

Antimicrobial activity [17]	The <i>in-vitro</i> antimicrobial activity in aqueous extract of <i>Colocasia esculenta</i> (AECE) leaves was studied against gram-positive bacterial strains i.e. <i>Streptococcus mutans</i> (MTCC-890), <i>Bacillus subtilis</i> (MTCC-121), gram-negative bacterial strains i.e. <i>Klebsiella pneumoniae</i> (MTCC-109), <i>Pseudomonas fragi</i> (MTCC-2458), <i>Escherichia coli</i> (MTCC483) and fungal strains <i>Aspergillus niger</i> (MTCC-281) <i>Candida albicans</i> (MTCC-227).	AECE showed maximum activity at low concentration against <i>Streptococcus mutans</i> among the selected microbes. In this study, the antimicrobial activity of the AECE was more effective in bacteria than fungus.
Antifungal activity [18]	The food poisoning methodology was used to test <i>Colocasia esculenta's in vitro</i> antifungal activity against two different types of mushrooms.	Compared to the aqueous extract of <i>Colocasia esculenta</i> , the alcoholic leaf extract exhibited higher antifungal activity.
Anti-diabetic activity [19]	In an alloxan-induced diabetes model, the effects of an ethanol extract of <i>C. esculenta</i> (EECE) leaves were described. In this investigation, EECE was given orally at doses of 100, 200, and 400 mg/kg, while metformin (450 mg/kg) was employed as a benchmark against diabetic rats produced by alloxan (120 mg/kg, i.p.).	EECE's blood glucose started to decrease at 4 hours (96 mg/dl), peaked at 6 hours (120 mg/dl), however the antihyperglycemic effect started to wear off at 24 hours. In the subacute trial, the 14th day's dose of 400 mg/kg resulted in a significant decrease in blood glucose (174.34 mg/dl).
Anti-oxidant activity [20]	Strong antioxidant activity and free radical scavenging ability were demonstrated in an <i>in vitro</i> antioxidant assay using an aqueous extract of <i>C. esculenta</i> corm extract. The antioxidant potential of <i>C. esculenta</i> corm extract was evaluated in this study using seven distinct assays: total phenolic content, total flavonoid content, total flavonol content, reducing power estimation, and the ability to scavenge radicals using 1,1-diphenyl-2-picrylhydrazyl (DPPH), NO, and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS).	The phytoconstituents of <i>C. esculenta</i> corm, such as tannins, saponins, flavonoids, steroids, carbohydrates, proteins, and glycosides, are primarily responsible for its antioxidant capacity. In an <i>in vitro</i> rat liver slice model, <i>Colocasia esculenta</i> whole leaf juice likewise inhibited the elicitation of lipid peroxidative reactions brought on by the presence of free radicals produced by the hepatotoxins CC14 and acetaminophen.
Anti-metastatic activity [21]	water-soluble extract of Taro (TE) potently inhibits lung colonizing ability as well as spontaneous metastasis from mammary gland-implanted tumors, in a murine model of highly metastatic ER, PR and Her-2/neu negative breast cancer. It modestly inhibits proliferation of some, but not all, breast and prostate cancer cell lines.	Complete blocking of tumor cell movement was achieved by TE. Prostaglandin E2 (PGE2) production was also suppressed and the expression of COX 1 and 2 mRNA was downregulated by TE treatment. The separated taro-derived proteins, tarin, and lectin that strongly and precisely prevent tumor metastasis.
Anti-inflammatory activity [22]	Anti-inflammatory properties of the ethanolic extract of leaves <i>C. esculenta</i> in Wistar rats using the models of carrageenan-induced pleurisy, cotton pellet-induced granuloma, and left hind paw edema. Carrageenan-	It decreased pleural exudates, prevented leukocyte migration, and decreased granuloma weight. Comparing the ethanolic extract to the standard and untreated control, the results showed

	induced rat paw edema was reduced by the ethanolic extract (100 mg/kg, p.o.). In the cotton pellet granuloma method.	a significant (P<0.05) anti-inflammatory effect.
Anti-Melanogenic Activity <sup>[23]</sup>	The isolated fraction from the methanolic extract of the tuber barks of <i>Colocasia antiquorum</i> var. <i>Esculenta</i> such as monoglyceride, (2'S)-1-O-(9-oxo-10(E), 12(E)-octadecadienoyl) glycerol as well as nine fatty acid	It showed inhibitory effects on melanin production in melan-a cells. Hence it could be used as de-pigmenting agents and also as good candidates for cosmetic development
Estrogenic activity <sup>[24]</sup>	The estrogenic effects of <i>D. odorate</i> isoflavone extract, <i>P. angulata</i> physalin-rich extract, and <i>C. esculenta</i> flavonoid glycoside-rich fraction on the reproductive organs and endocrine glands of female rats at three different life cycle stages were assessed using <i>in vivo</i> pharmacological experiments.	The findings showed that in prepubescent, pubescent, and adult ovariectomized female rats, <i>C. esculenta</i> fraction (80 mg/kg) exhibited better estrogenic activity. In contrast, <i>D. odorate</i> isoflavones only caused the prepubescent rats' pituitary glands to weigh more after prolonged treatment, and <i>P. angulata</i> physalins caused the weight of the adrenal glands in ovariectomized rats.

## Conclusion

There are reports that *C. esculenta* is utilized as a dietary supplement and traditional medicine in several parts of the world. It has been discovered that both whole plants and individual plant components are used for a variety of medicinal purposes. The current review concentrated on the phytochemistry, pharmacological activity updates, Ethnomedicinal usage, and botanical description of *C. esculenta*. It has been stated that this plant contains a variety of phytochemicals, including phenol steroids, alkaloids, flavonoids, terpenes, and glycosides. The starch and the gum obtained from the tubers can be commercially made use of in pharmaceutical industries in form of binder, matrix forming agent, thickening agent etc. Numerous pharmacological characteristics are also displayed by the plant, including hepatoprotective, anti-inflammatory, antibacterial, anti-helminthic, hypolipidemic, anticancer, anti-melanogenic, anti-inflammatory, antioxidant, and neuropharmacological activity. To determine the connection between the traditional usage, bioactive components, and documented pharmacological activity, more comprehensive research is required.

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