Taro (*Colocasia esculenta*) 18

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Abstract

Colocasia esculenta is a traditional, inter-developed, and a tuberous crop harvested across the globe in tropical and subtropical areas. It correlates to the "Arecaceae" own family and is also called the "taro," the name was given to this family's tubers and roots. It is grown mainly as an affluent source of starch for the use of its palatable corms and leaves as an edible vegetable. Historically, taro was used owing to its antitumor, antimicrobial (antibacterial and antifungal), antidiabetic, antihepatotoxic, and antimelanogenic characteristics. Recent studies have documented the presence in the taro of bioactive compounds such as flavonoids, steroids, β-sitosterol, etc., which are confirmed for their health benefits. In the twenty-first century, where the consumer demands natural ingredients integrating food products, taro has various potential for use in the food industry, but after investigating its medicinal and pharmaceutical properties. This analysis will shed light on taro's bioactive and nutraceutical compounds and the possible health-promoting implications thereof.

Keywords

Colocasia esculenta · Antioxidants · Antimicrobial · Flavoniods · Health benefits

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18.1 Botanical and Common Names

Taro belongs to the *Colocasia* group which has monocotyledonous Colocasieae subfamily. Given the ample availability of vegetative propagation, the categorization of the Colocasia variety with a wide family is considerably mixed. The mainly domesticated taro is sorted as *Colocasia esculenta*, while the sort is also considered multiform. The taro has botanical varieties named twice: *Colocasia esculenta* (L.) *Schott var. Schott var: Esculenta* and *Colocasia esculenta* (L.) Schott Antiquorum (Purseglove 1972). In several areas, taro is known by several names, such as edode or malanga. Taro plant is known as "dmmbhe" in the Republic of South Africa, "cocoyam" in Ghana, "ndalo" in Fiji, "taro" in Tahiti, "talo" in Samoa, "gabi" in Philippines; "amateke" in Rwanda; "colcas" in Arabia; "kalo" in Hawaii, and "arbi" in India. Cultivated as a decorative herb, taro is also known as "elephant ears" (Dastidar 2009). The generic name of taro is derived from the Greek word *kolokasion*, meaning that both *Colocasia esculenta* and *Nelumbo nucifera* have an edible root component (Shekade et al. 2018).

18.2 Introduction

Taro is an erect tuberous perennial plant, primarily grown across tropical and subtropical areas of the globe (Kaushal et al. 2013). Taro's botanical name is *Colocasia esculenta*, which belongs to the family of Arum (*Araceae*). This is the sixteenth most grown herb in over 60 countries worldwide. It is an abundantly grown crop in the India and is known by various titles such as eddoe, arvi, and arbi. The main reason for its production is that the edible underground corms contain 70–80% of the starch, but a leafy vegetable is also used. In India, this crop has remarkable dietary significance and has multiple uses in the form of its edible stem and corm in various culinary preparations (Nakade et al. 2013). The taro plant's juice acts as a stimulant, rubefacient, styptic, and can be used to treat internal buboes, otalgia, adenitis, and. The taro corm juice is laxative, demulcent, and urodynamic. For health-promoting attributes such as antidiabetic, antidepressant, and antihelmintic action, the leaves have been reported (Lin and Huang 1993). The taro leaves are affluent in dietary fiber, which is advantageous for their positive function in controlling intestinal movement, enhancing the quality of dietary bulk and feces due to their water absorption capacity (Saladanha 1995).

18.2.1 History

Taro is one of the oldest cultivations in the world, and has a very long history; even in the Chinese books it is listed as early as 100 B.C. This is known to be native to Southeast Asia's humid tropical regions, including India, and to neighboring countries in east China and Burma and the south to Indonesia. This is eventually transferred to Melanesia, China, Polynesia, and Hawaii; it was brought to Egypt and the eastern Mediterranean in historical times, From there to Nigeria, the Guinean coast, and the African-Caribbean coast. Data collected from the Papua New Guinea highlands shows that working on taro has been participating since ten thousand years ago, while residues of starch from Colocasia and Alocasia have also been detected on stone implements from Solomon and Buka Islands that were around 28,000 years ago (Loy et al. 1992). Historically, taro represents a predominant staple food of the people living on the Pacific Islands, particularly Hawaii, New Zealand, Papua New Guinea, and the West. It became very important for the Hawaiian people, called it "kalo" and identified with their gods and ancestors, and used for medicinal purposes (Brown and Valiere 2004; Brown et al. 2016). This plant is of special cultural significance to the Hawaiian indigenous people, the Maoli Kanaka. Such people claimed that taro had the greatest life force for all the foods and used the term "Poi," which is the Hawaiian term for the first Polynesian staple food product produced from the plant's corm portion. All (taro and Poi) serve as symbols and modes of survival, providing a ceremonial relationship for the Hawaiian people (Brown et al. 2016). It is also widely cultivated in western India and north Africa. It is grown throughout the region of Asia in southern and primal China and to a little level inside Hindustan; this crop represents also a basic diet in several drylands (Lim 2015).

18.2.2 Production

Taro production worldwide is estimated at 10.2 metric tons in 2017. Nigeria is the world's leading producer with 3.25 metric tons, covering about one-third of the world's production capacity data. Following this country is China in taro's output capacity, with estimates of around 1.9 metric tons. Taro is produced from around 1.72 million hectares worldwide, on an intermediate yield of 5.93 tons/ha. Based on the lowest external resource supply, the bulk of world output comes from the economically developed countries characterized by smallholder production systems (Singh et al. 2012). This crop was grown in many countries to fill the gaps in seasonal food while other crops were still grown on the fields because of their ability to yield equally under conditions where other crops could not yield due to various crop restrictions (Rashmi et al. 2018). The paddy field areas can also be used to develop the taro, where water is available in abundant or upland conditions, where rainwater or supplemented irrigation water is used for irrigation purposes (FAO 1999). It can be grown in flooded conditions among the few crops such as rice or lotus. The reason may be the presence of airspaces in the leaves leafstalk, which helps to exchange submersed gases in the surrounding area and fulfill its dissolved levels of oxygen. To achieve the optimum yield of taro, water levels should be managed so that they remain underwater at the base of the plant (FAO 1999).

18.2.3 Botanical Description

The taro plant is herbaceous, tuberous in nature, with a strong short caudex, flowering together, and leafing. Leaves are normally elongated arrows or heart-shaped and pointing earthward in the cluster (Prajapati et al. 2011). This plant has a few meters high erect stems and can be orange, red-black, or variegated. The adventitious and shallow root system develops ample quantities of fine starch from the corm (Reyad-ul-Ferdous et al. 2015). The broad elongated leaves that have a height of 1–2 m are called "elephant head." The dimensions of the leaves maybe 30–90 cm long & 23 inches thick, and are acquitted at the close of standing, broad, lush, 78 inches high leafstalks in crowns (Heuze et al. 2015; SafoKantaka 2004). The taro plant can grow to a height of 2 m. The plant uses reproductive rhizomes such as tubers and corms, while it also produces a bunch of 2–5 fragment inflorescences in the axil of leaves (Diwedi et al. 2016). Generally, the taro corms are cylindrical and about 30 cm in diameter around 15 cm, and can vary in scale, shape, and color.

18.3 Antioxidant Properties

Taro has been customarily used as a therapeutic restore herb. A large variety of bioactive mixtures from all plant portions of this species can be collected. The phytochemicals are compounds extracted from plants that have various homegrown and therapeutic properties. They show properties that are soothing, antimicrobial, antifungal, antibacterial, and antihypertensive (Mengane 2015). Diverse parts of taro plants are the main origins of components of phytochemicals that show mild to important biological activity against big organisms and diseases.

18.3.1 Leaves

The two pharmacologically active classes of compounds such as flavonoids and triterpenoids are found mainly in extracts of the *Colocasia* leaf. Vicenin-2, iso-vitexin, iso-vitexin 3′-O-glucoside, vitexin X′-O-glucoside, iso-orientin, orientin-7-O-glucoside, luteolin 7-O-glucoside are the flavonoids present in the concentrate of the *Colocasia leaf* (Iwashina et al. 1999). The *Colocasia* plant leaves are also rich in mineral compounds such as CaC_2O_4, minerals (calcium phosphorus, etc.), starch, vitamins A, B, C, and so on (Sheth 2005). The presence of anthocyanins, namely, cyanidin-3-rhamnoside, cyanidin 3-O-glucoside, and pelargonidin 3-O-beta-D-glucoside, has been demonstrated by phytochemical analyses on the *Colocasia* concentrates. These anthocyanins have cell strengthening exercises as apparent from past tests (Noda et al. 2002; Cambie and Ferguson 2003; Kowalczyk et al. 2003). Anthocyanins are predicted to be present at *Colocasia* leaves of esculenta plants are hepatoprotective of lipid peroxidative movement.

18.3.2 Juices

The plant leafage juice is rubefacient, excitant, astringent, and practicable for indoor hemorrhages, redness, otalgia, and nodes. The juice from the corm is softening, purgative, and painkiller. The leaves of the plant have been discovered to be hostile against the diseased person and mitigating activity for helminthic diseases (Md. Reyad-ul-Ferdous et al. 2015). *Colocasia* species have an antiquated yield and are applied throughout the world: Europe, Asia, western India, and South America. It is all being built through the muggy tropics. The plant's leaf juice is stimulant and rubefacient just like a styptic (Dnyaneshwar et al. 2018). In snake nibble, the leaf squeeze used in plant root just as food contamination as conventional medicines. A demulcent, diuretic, and anodyne corm juice (Kubde et al. 2010).

18.3.3 Root

Healthily, taro starches, roots, and tubers have an incredible potential to have accessible dietary fiber wellspring. Owing to the high dampness content of tubers, the energy obtained from tubers is around 33% of that of an equivalent weight of *Oryza sativa* or rice. However, large returns of roots and tubers offer more vitality per unit of land; every 24 h is equated to oat cereals all in the protein cognitive content of stems and stalks comprises less running at a dry weight premise from 1% to 2% (Food and Agriculture Organization 1990). The stem of taro holds to a greater extent than double the potato sugar substance and yields 135 kcal per 100 g and 11% rough protein on the base of juiceless weight. This comprehensive value of starch and protein is substantially more prominent than other historic crops such as yam plant, manioca, or ocarina (Food and Agriculture Organization 1999). Nevertheless, taro's protein and lipid are small, but high in sugars, vitamins, and minerals (Del Rosario and Lorenz 1999). This produces 85–87% carbohydrate on the base of juiceless weigh with a little granule size of 3–18 micrometers and various supplements, zinc, ascorbic acid, Vitamin B1, Vitamin B2, and Vitamin B3, for example, are more prominent than other ancestor crops (Jirarart et al. 2006).

18.4 Antioxidant Properties of Products Prepared from Taro

Because of its oxalate content, splashing, washing, or cooking of taro corms and dry leaves are prescribed before they are sustained (Pheng et al. 2008; Babayemi and Bamikole 2009). It is conceivable that taro is processed by various techniques to lessen the lethality and boost the attributes of convenience and ability. Such methods of handling include scraping, bubbling, steaming, flouring, and drying (Hang and Preston 2009). Once cooked without meat, taro retains its nutritional value, so it must be thoroughly cooked to counteract the tingling of the mouth and throat. For starters, bubbling, whitening, steaming, stewing, and singing and weight cooking, taro corms and leaves are typically devoured by people in Asia and Oceanic nations after warm narcotics. These techniques are found to be powerful in improving edibility, expanding bioavailability of supplements, and limiting the enemy of dietary components (Savage et al. 2009; Hang and Preston 2009). There was a significant reduction in the proximate composition, mineral content, phytochemical components and antinutrient contents when taro corms were made into powder and were further decreased when processed into taro noodles and cookies (Soudy et al. 2010). Both cooking time and temperature are important parameters to protect the supplements and dispense with the counter dietary variables. Cooking them again builds movement for cell reinforcement, rough fat, unrefined protein, and unrefined fiber (Soudy et al. 2010).

18.4.1 Flour

A noteworthy issue of taro is that while gathering, the stalks are powerless to physical harm, hence prompting a prominent crop to collect misfortunes (Onwueme 1999). Taro could be treated into flour to defeat those misfortunes. As indicated in Obadina and Hannah (2016) and Oyindamola et al. (2016), flour handling extends the period of taro usability. Root crops that are wealthy in starch are among the other elective flour wellspring. Even though wheat flour is contrasted with high starch protein, root harvesting, for example, can be considered as an elective feature for cakes and other pastry kitchen products that also have a lot of supplements and nutrients (Prajapati et al. 2011; Lim 2015).

18.4.2 Taro Leaf as Chicken Feed Ingredients

Shortly, it is predicted that in most developing countries there will be a considerably increase and continuing demand for protein foods for human consumption (Hang and Preston 2009). But today animal protein deficiency is one of the world's major health problems, particularly for children in developing countries, exacerbated by rapidly increasing population growth (FAO 2010). Because of a scarcity of ordinary feedstuffs, chicken items become the compass of destitute citizens, essentially grains and vegetables, which are additionally exceptionally required for direct human use. Thus, substituting cereals and expensive and less available agro-industrial by-products for unconventional sources of raw materials that are less exploited by humans is one of the solutions for reducing production costs and contributing to increased animal protein supply (Anaeto and Adighibe 2011). Also, most chicken fodders are made of oats that are deficient in certain essential amino acids resulting in synthetic amino acid supplementation, and rural farmers are therefore unable to increase the yield of meat. Thus, the incredible expense of grains and protein enhancements and vulnerability to their feasible supply squeezed the need to look for other potentially unconventional sources of feed that are generally less used for human use.

18.4.3 Taro Corm Flour as Complementary Food Ingredients

Factors such as category of dietary patterns determined by the elderly, acculturations, traditions, faiths, food tab uses, past knowledge of feasting designs, husbandry, unequal nutritional cognition, geographic preferences, and seasons affect the choices of complementary foods (Suhasini and Malleshi 2003). Improvement of reciprocal nourishment is guided by the high dietary benefit to enhance bosom sustaining, agreeableness, low cost and utilization of neighborhood sustenance things (Ferguson and Darmon 2007). For example, wheat, maize, rice, grain, teff, oat, millet, or sorghum, the usual correlative sustenance of porridges depends on bland staple nutrition, yet in certain areas it also forms slender roots or tubers that create gooey porridges that are hard to eat for young people (Temesgen 2013; Tessema and Belachew 2013).

18.5 Characterization of the Chemical Compounds Responsible for Antioxidant Proprieties and the Pathways Involved in Biological Activities

18.5.1 Phytochemicals

Taro also has some substances that promote health which include antioxidants and phytochemicals that have a consequential impact on human health. They contain exceptionally good quantities of normal carotenoids which are cancer prevention agents as well as other possible medical benefits. As already mentioned, both can be converted into nutrient Vitamin A by the body; however, β-carotene affects α-carotene around double the provitamin (Nip 1997).

18.5.2 Phenolic Acids

Taro tubers are high in starch and include cyanidin-3-glucoside anthocyanin. Like flavonoids, it is believed that the related anthocyanins improve blood circulation by decreasing capillary fragility to improve visual perception, act as potent antioxidants, act as anti-inflammatory agents, and inhibit the growth of human cancer cells (Wagner 1985). Flour from taro corms, dried and processed, has been documented to contain simple assimilation starch, and is widely used along these lines as newborn child support (Del Rosario and Lorenz 1999). This is also used for anthocyanin analysis, in particular as regards abaxial and adaxial anthocyanin fixation.

18.5.3 Oxalic Acid/Oxalates

Huang and Tanudjaja (1992) estimated oxalate in corms of *Colocasia* by using chromatography of the solid anion-trade segment. The segment was created in the examination with a versatile period of 3 mM of phthalic corrosive, with its pH changed according to 3.5 using lithium hydroxide. The stream rate was 1.0 ml/min equilibrated. With a conductivity-finder, the system was fine. Both oxalates out and solvent oxalates were measured individually in 1 N HCl and separate water. The contrasts between them were insoluble oxalate substance by count. In nine taro cultivars, the complete oxalate substance was in the range of 19–87 mg/100 g of new weight and solvent oxalate substance. Insoluble oxalate substance was found to vary from 29.35% to 73.97% of the absolute oxalate substance in tested plant corms (Chai et al. 2004). Oxalates are a noteworthy limiting. The proximity of oxalates which give bitter taste or cause disturbance when eating crude or natural food is an element in taro use. The needle-like oxalate-calcium crystals, raphides, cause this acridity which may infiltrate delicate skin (Bradbury and Nixon 1998).

18.6 Health Benefits

18.6.1 Antimicrobial Activity

Aqueous accumulation of *C. esculenta* was accounted for its action against antimicrobials. The study was performed for separate microscopic organisms to be specific *Escherichia coli, Aeromonas hydrophila, Flavobacterium* sp., *Edwardsiella tarda*, *Klebsiella* sp., *Salmonella* sp., and *Vibrio alginolyticus*, *V. parahaemolyticus*, *V. cholera*, *and Pseudomonas aeruginosa.* The separate plant showed the most intense movement against *S. mutans* between all the microorganism strains selected. The *C. esculenta* demonstrated strong antimicrobial activity against certain low-fixation microscopic species and parasites (Singh et al. 2011).

18.6.2 Antidiabetic Activity

The ethanol concentrates on *C. esculenta*'s antidiabetic action. The antidiabetic action of the ethanol concentrate of *C. esculenta* (EECE) forgets was conveyed in rodents utilizing alloxan-initiated diabetes model. EECE (100, 200, and 400 mg/kg) and metformin (450 mg/kg) were orally controlled in diabetic rodents actuated by alloxane (120 mg/kg, i.p.) At 4 h (96 mg/dl), the beginning of blood glucose decrease was reported, with a crest at 6 h (120 mg/dl) but hostile to hyperglycemic effect decreased at 24 h. During the fourteenth day, the most significant drop in blood glucose was observed (174.34 mg/dl) at the 400 mg/kg section of the subacute test. Such findings indicated that EECE (400 mg/kg) demonstrates antihyperglycemic movement in diabetic rodents initiated with alloxane (Patel et al. 2012; Kumawat et al. 2010).

18.6.3 Anti-lipid Peroxidative Activity

The free radical rummaging property was accounted for in whole leaf juice *C. esculenta*. The impact of in vitro free radical rummaging was contemplated with the use of rodent liver cut models on liver cells. The liver cuts were brooded in the vicinity of the CCl4 and acetaminophen cytotoxic centralizations. The checked rises and anticipation of exhaustion of complete tissue glutathione were seen within the sight of *C. esculenta* entire leaf juice (Bhagyashree and Hussein 2011a, b).

18.6.4 Antimetastatic Activity

Breast malignant growth mortality stems primarily from a case of metastatic infection. The compound(s) deriving from the underlying foundations of *C. esculenta* plant can prevent metastasis in tumors, both conceivably and directly. In a preclinical model of metastatic breast disease, it displayed clear movement. Taro removes treatment with a similarly repressed mixture of prostaglandin E2 (PGE2) and downward directed cyclooxygenase 1 and 2 mRNA. Taro extricate humbly hinders the expansion of a few, but not all, cell lines of the breast and prostate disease, and it completely squares the relocation of tumor cells (Kundu et al. 2012).

18.6.5 Antifungal Activity

Yang et al. tested the antifungal motion of taro alongside tests of atomic cloning and recombinant efficiency articulation. CeCPI, a cysteine protease inhibitor (cystatin), was isolated from *Colocasia esculenta*, a taro corm. The test indicated that the recombinant CeCPI protein showed an unequivocal movement of the cysteine protease inhibitor. So, the analysis found a simple toxic effect of the plant on mycelium production from phytopathogenic parasites (Yang and Yeh 2005).

18.6.6 Anti-inflammatory Activity

The ethanolic leaves concentrate on *C. esculenta* have the movement minimizing. The study was carried out in Wistar rodents using the granuloma model caused by carrageenan instigated left rear paw edema, carrageenan-prompted pleurisy, and cotton pellet. The findings showed that when contrasted, the ethanolic extract shows vital calming action, and normal and untreated regulation (Shah et al. 2007).

18.7 Other Uses/Applications

18.7.1 Medicinal Uses

C. Esculenta as discussed earlier has various restorative uses. In addition, every part of the plant, viz. leaves, roots, and tubers showed numerous restorative properties. The reported properties against lipid peroxidative action, antimetastatic, antifungal, mitigating, and some more areas antimicrobial, antihepatotoxic, hostile to diabetic. Munda clan individuals generally use taro corm as a solution for body hurt. For alopecia, the juice derived from the plant's corm is used as an expectorant, stimulant, hors d'oeuvre, and astringent. The crop contains adhesive when cooked and is found to be a convincing tonic to the nervine (Soumya et al. 2014).

18.7.2 Pharmaceutical Applications

The gum got similarly from the tuber as starch. *C. Esculenta* plant can be used as a pioneering spread and administrator of mucoadhesive molding systems (Soumya et al. 2014). Soumya et al. (2014) successfully arranged, using metoprolol succinate as the model medication, to release and survey taro gum network tablets. As self-ruling variables, the calculation of taro gum (X1) and polyvinylpyrrolidone (PVP) K30 (X2) was chosen. As the destitute component, the time needed for 90% of the in vitro drug release was chosen. Tablets were prepared by direct weight and surveyed for various post-weight parameters such as tablet hardness, friability, weight variety, cure quality, and breakdown in vitro (Soumya et al. 2014). Another Arora et al. review paper declared the use of taro gum being created from mucoadhesive system tablets. Domperidone structure tablets as a model drug have been stuffed using a direct weight process. This study demonstrated subordinate fascination with mucoadhesive and release the retardant potential of taro gum in the enumeration of gastro retentive mucoadhesive cross-section tablets (Gurpreet et al. 2011). Chukwu and Udeala (2000) mulled over enough *C. esculenta* gum in the subtleties of paracetamol and metronidazole tablets which are incapable of being compressed. Ampleness of polysaccharide gum received from the *C. esculenta* in the case of insufficiently compressible medicines was surveyed with acacia and methylcellulose as folios. At 4% w/w, the apparent centralization of *Colocasia* gum in metronidazole tablets and 6% w/w in paracetamol tablets showed long disintegration time and postponed release profile. The clasp used for analysis yielded tablets that showed better characteristics of in vitro release (Chukwu and Udeala 2000). *C. Esculenta* polysaccharide can be used as a disintegrant in orally separating tablet arrangements. The decaying property was described as being practically indistinguishable from that of the super-disintegrants available in monetary terms.

18.8 Conclusion

In this analysis, we discussed the botanical definition, phytochemical, and pharmacological usage of *C. Esculenta*. For various pharmacological activities such as analgesic, anti-inflammatory, anticancer, antidiarrheal, astringent nervine tonic, and hypolipidemic activity the plant has been studied. The plant also contains various biologically active phytoconstituents, such as flavonoids, sterols, glycosides, and other micronutrients, chemically. In the medicinal and pharmaceutical areas, therefore, it must be used to its full ability. *C. esculenta* is a mainly cultivated herb, which has been used as food and medicine since ancient times.

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