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Taro (*Colocasia esculenta*): An overview

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Abstract
Colocasia esculenta is a tropical plant grown primarily for its edible corms, the root and vegetables. It is most commonly known as taro and is widely cultivated in the high rainfall areas under flooded condition usually by small farmers. This study details about morphological characters of taro and their use as food and; region and season of cultivation.

Keywords: Taro, edible, medicinal, morphology

Introduction
Herbs are predominantly used to treat cardiovascular, liver, central nervous system (CNS), digestive, and metabolic disorders. Given their potential to produce significant therapeutic effect, they can be useful as drug or supplement in the treatment or management of various diseases. Herbal drugs or medicinal plants, and their extracts and isolated compounds have demonstrated a wide spectrum of biological activities [1]. Selection of scientific and systematic approach for the biological evaluation of plant products based on their use in the traditional system of medicine forms the basis for an ideal approach in the development of new drugs from plants. One such plant is *Colocasia esculent* Linn.

Taro (*Colocasia esculent* Linn.) is a vegetative propagated tropical root having its origin from South-east Asia. It occupies 9th position among world food crops with its cultivation spreaded across Africa. Taro tubers are important sources of carbohydrates as an energy source and are used as staple foods in tropical and subtropical countries. It is largely produced for its underground corms contain 70–80% starch. There are numerous root and tuber crops are grown in the world. Taro is one of such crops grown for various purposes. It is an erect herbaceous perennial root crop widely cultivated in tropical and subtropical world belonging to genus Colocasia in the plant family called Araceae [2]. The crop has been largely produced in Africa even though the time of its spread to the region is unknown and nowadays cultivated in Cameroon, Nigeria, Ghana and Burkina Faso where it has gained high importance [3]. It has been suggested that the crop was cultivated to fill seasonal food gaps when other crops still in the fields because of its potential in giving reasonable yield under conditions where other crops may unable to give produce by various crop production constraints [4].

The corm of taro is relatively low in protein (1.5%) and fat (0.2%) and this is similar to many other tuber crops. It is a good source of starch (70–80 g/100 g dry taro), fiber (0.8%), and ash (1.2%). Taro is also a good source of thiamine, riboflavin, iron, phosphorus, and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese [5]. Taro can also be used for entrapment of flavouring compounds [6].

It is locally referred to as "*brobey*" and cultivated on subsistence basis for its cormels and leaves, which are boiled and eaten. In other parts of the world taro is made into ice cream and drinks [7]. Taro leaves and tubers are poisonous if eaten raw; the acrid calcium oxalate they contain must first be destroyed by heating.

Taro is rich in digestible carbohydrates and micronutrients [8]. Taro contains antinutrient factors such as: oxalate, Phytate and tannin. Taro deteriorates rapidly as a result of its high moisture and has been estimated to have a shelf-life of up to one month if undamaged and stored in a shady area [9]. Taro foods are useful to persons allergic to cereals and can be consumed by infants/children who are sensitive to milk.

Studies conducted in Asia in the past have reported that babies who were fed poi-a type of baby food prepared from taro were found to suffer less from health conditions such as diarrhea, pneumonia, enteritis and beriberi than babies fed with rice and bread [10]. The nutritive value of poi as being hypoallergenic, rich in calcium, potassium, phosphorus, magnesium, B vitamins, vitamin A and C, high in fiber and serves as a slow release energy food source. Apart from the vast uses of taro for food, it can also be used as an additive to render plastics biodegradable [11]. Taro has a small starch grain about a tenth of that of potato (1-6.5 micrometers) making it more digestible. Taro is known to be a good source of carbohydrate, fiber, minerals especially potassium and vitamins (especially B-complex) which is more than that found in whole milk and vitamin A and C. It is rather low in ascorbic acid and carotene with the amount of carotene being the same level as that found in cabbage and twice that found in potato [12].

Table: 1 Different Vernacular Names of Colocasia esculenta

S. No	Names	Language
1	Taro	English
2	Aravi	Hindi
3	Alupam	Sanskrit
4	Alavi	Gujarati
5	Alu	Marathi
6	Sempu	Tamil

1. Taxonomy and morphology of taro

(A) Taxonomy: (Colocasia esculenta L) known as Taro belongs to the family Araceae. Linnaeus originally described two species which are now known as Colocasia esculenta and Colocasia antiquorum of the cultivated plants. Taro is related to *Xanthosoma* and *Caladium*, plants commonly grown as ornamentals, and like them it is sometimes loosely called elephant ear. Taro which is made up of at least 100 genera and more than 1500 species [13]. It has been reported as corms of the wild taro cannot be used as food due to an extremely high concentration of calcium oxalate crystals [14]. The specific epithet, esculenta, means "edible" in Latin. Taro is related to Xanthosoma and Caladium, plants commonly grown as ornamentals, and like them it is sometimes loosely called elephant ear.

Table 2: Botanical classification of Taro (colocasia esculenta)

Rank	Scienticfic Name
Kingdom	Plantae (Plants)
Subkingdom	Tracheobionta (Vascular plants)
Super division	Spermatophytes (Seed plants)
Division	Magnoliophyta (Flowering plants)
Class	Liliopsida (Monocotyledons)
Subclass	Arecidae
Order	Arales
Family	Araceae (Arum family)
Genus	Colocasia Schott (colocasia)
Species	*Colocasia esculenta* (L.) Schott (Coco yam)
Synonyms	Alocasia dussil Dammer Alocasia illustris W. Bull

(B) Morphology: Taro is naturally a perennial monocotyledonous herb,but for practical purposes is harvested after 5-12 months of growth [15]. It grows to a height of 1-2 m consisting of a central corm, lying just below the soil surface, from which leaves grow upwards, roots grown down wards, while cormels, daughter corms and runners grow laterally [16]. It has heart-shaped green or purple leaves together with long petioles, fibrous roots and cylindrical or often irregular nutrient storage organ (corm) and the nature of flowering, fruiting and seed production by wild or cultivated taros (Colocasia esculenta) has not been fully understood [17]. Female inflorescence short, male inflorescence long, cylindrical, usually interposed neuters between the two. Appendix erect, elongate-conical or fusiform, subulate or abbreviate. Male flowers 3-6 androus [18]. However, Castro reported as taro seldom flowers and when flowers occurs the inflorescence consists of a cylindrical spadix of flowers enclosed in a 12-15 cm spathe resulting unisexual with the female flowers located at the base of a spadix and the male flowers at the top [19].

Genetic diversity in taro: Mace and Godwin reported diploids (2n=2x=28) and triploids (2n=3x=42) chromosomes in taro while diversity study using simple cytological techniques [20]. Taro chromosome number is 2n=14, 28, and 42 and 2n=36 and 48 in India and suggested as the genetic instability might be due to cultivation for long period of time in the region of center of diversity [21]. Quero-Garcıa *et al.* stated as taro is highly polymorphic, allogamous and protogynous species [22].

Morphological characterization of taro: Morphological taro characterization can be done based on its corm, stolon, leaf, petiole and floral characters and other quantitative traits. According to Lebot *et al.* there was high morphological variability in taro accessions in Southeast Asia and Oceania [23]. The variability with regard to morphological traits includes colour, shape and size of tuber, petiole length and colour, and stolon formation. Moreover, Manzano *et al.* reported presence of greatest morphological variability in root colour, cormel flesh colour, corm dry matter percentage, corm shape and cormel shape in Colocasia esculenta collected from Asia, Africa and America [24].

Leaf: The taro leaves rich in protein content (23%) found might be favourably complemented the high carbohydrate contents (87%) found in the tuber part of the plant as a source of human food [25]. The leaves of taro have been reported to be rich in minerals like Ca, P, Fe, and vitamins. The high level of dietary fibre found in the taro leaf are also advantageous for their active role in the regulation intestinal transit, increasing dietary bulk and faeces consistency due to their ability to absorb water [26].

Table 3: Nutrition value of leaves

Nutrition Facts Of Leaves			
Calories	42		
Fats	0.7g		
Saturated Fat	0.2g		
Sodium	3mg		
Carbohydrates	6.7g		
Dietary Fiber	3.7g		
Sugar	3g		
Protein	5g		
Vitamin A	96%	Vitamin C	87%
Calcium	11%	Iron	12%

Root: Nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates. The energy from tubers is about one-third of that of an equivalent weight of rice or wheat due to high moisture content of tubers. However, high yields of roots and tubers give more energy per land unit per day compared to

cereal grains In general the protein content of roots and tubers is low ranging from 1 to 2% on a dry weight basis [27]. The corm of taro contains more than twice the carbohydrate content of potatoes and yield 135 k cals per 100 g and 11% crude protein on a dry matter (DM) basis. These reported carbohydrate and protein values are even higher than other root crops like yam, cassava or sweet potato (FAO, 1999). Though, protein and fat content of taro are low, but is high in carbohydrates, fiber and minerals (Del Rosario and Lorenz, 1999). It contains 85-87% starch on a DM basis with small granule size of 3-18 µm and other nutrients such as zinc, vitamin C, thiamine, riboflavin and niacin are higher than other root crops [28].

Fig 1: Taro tubers

Fig 2: Taro leaves

Fig 3: Taro plant

Table 4: Nutrition value of Taro root. RDA (Recommended Dietary Allowances)

Nutrition value per 100g		
Principle	**Nutrient value**	**Percentage of RAD**
Energy	112K cal	6%
Carbohydrates	26.46 g	20%
Protein	1.50 g	3%
Total fat	0.20 g	<1%
Cholesterol	0 mg	0%
Dietary fibers	4.1 g	0%
Vitamins		
Folates	22 µg	5.5%
Niacin	0.600 mg	4%
Pantothenic acid	0.303 mg	6%
Pyridoxine	0.283 mg	23%
Riboflavin	0.025 mg	2%
Thiamin	0.095 mg	8%
Vitamin A	76 IU	2.5%
Vitamin C	4.5 mg	7%
Vitamin E	2.38mg	20%
Vitamin K	1 µg	1%
Electrolytes		
Sodium	11 mg	<1%
Potassium	591 mg	12.5%
Minerals		
Calcium	43 mg	4%
Copper	0.172 mg	19%
Iron	0.55 mg	7%
Magnesium	33 mg	8%
Manganese	0.383 mg	1.5%
Selenium	0.7 µg	1%
Zinc	0.23 mg	2%

Source: USDA National Nutrient data base.

Table 5: Geographical distribution of Taro production

Top taro producer of 2014(million metric tons) [29]	
Nigeria	3.3
China	1.8
Cameroon	1.6
Ghana	1.3
Papua New Guinea	0.3
World total	10.2

Nutritional value of taro: Carbohydrate (expressed as nitrogen free extract, NFE) content reported has been estimated by subtracting the moisture, crude protein, ash, fiber and fat from 100. Zinc and iron content has been analyzed following the AOAC (1990) dry ashing procedure and standard analytical method for atomic absorption spectrophotometry [30].

Phytochemical Contents: The total phenolic content was determined by the Folin-Ciocalteu Assay while the total tannin analysis was conducted using the modified vanillin method. The total flavonoid concentration was measured using a colorimetric assay developed by Zhishen *et al*. [31]

Carbohydrate: The high level of carbohydrate content observed in raw taro, taro powder, noodles and cookies agrees with the findings reported by FAO [18] that the main nutrient supplied by taro, as with other roots and tubers, is dietary energy provided by the carbohydrates [32].

Starch: Taro corm has been reported to have 70–80% (dry weight basis) starch with small Granules. Because of the small sizes (1–4 m in diameter) of its starch granules, taro is highly digestible and as such has been reported to be used for

the preparation of infant foods in Hawaii and other Pacific islands [33]. Taro starch is easily digestible, the starch grains are fine and very small, it has hypoallergenic nature and also the starch is gluten free [34]. Taro starch is also good for peptic ulcer patients, patients with pancreatic disease, chronic liver problems and inflammatory bowel disease and gall bladder disease [35]. The most important sugar in taro is sucrose, but fructose, maltose, glucose and raffinose are also present. Malic acid is the most important organic acid (60%) followed by citric acid (25%) and oxalic acid (15%) [36].

Moisture: Since taro is root crop its moisture content is very high and accounts two third of the total weight of the fresh crops [37]. Moisture content of taro varies with variety, Growth condition and harvest time. In general the moisture content of taro ranges from 60- 83% [38].

Protein: Taro composes high protein than other root crops because of the presence of symbiotic soil. Bacteria in the root and rhizome part of taro. These bacteria fix atmospheric bacteria and increase nitrogen occurrence in the corm and leaf More over the bacteria used as plant growth enhancer due to release of growth hormone to root and distributed to the whole part of the plant. The free-living nature of these soils bacterial also helps the taro crop to grow at different environmental and ecologic conditions. These properties have economic and ecologic important to the environment [39].

Total Ash: Taro contains fairly high amount of ash. From which it can be inferred it contain good mineral contents. The ash contents of taro ranged from 3.54 - 7.78% [40]

Health benefits of taro

Phytochemicals: Taros have high amount of β-carotene in the corm and will impart vitamin A and antioxidant property in the body. B-carotene differs only very slightly in terms of structure. They are very common carotenoids, and are antioxidants, as well as having other potential health benefits. As mentioned earlier, both can be converted into vitamin A by the body, though β-carotene has about twice the provitamin A activity as α- carotene [41].

Phenolic acids: Taro tubers are rich in starch and the tubers contain anthocyanins, cyanidin 3-glucoside. In common with flavonoids, the related anthocyanins are reputed to improve blood circulation by decreasing capillary fragility to improve eyesight, to act as potent antioxidants, to act as anti-inflammatory agents, and to inhibit human cancer cell growth [42]. It has been reported that flour from taro corms, dried and milled contains easy digestion starch and therefore is widely used as infant food [43]. It is also used for anthocyanin study experiments especially with reference to abaxial and adaxial anthocyanic concentration [44].

Oxalic acid / oxalates: Oxalates are one major limiting factor in the utilization of taro is the presence of oxalates which impart acrid taste or cause irritation when raw or unprocessed foods from them are eaten. This acridity is caused by needle-like calcium oxalate crystals, raphides that can penetrate soft skin [45]

Anticancer Activities: Cancer is a leading cause of death worldwide, and it is mostly related to unhealthy food habits and lifestyle. It is important to find ways to reduce and prevent the risk of cancer through dietary components, which are present in plant foods. Cancer is a multistage disease condition and tapping at any initial stage could help attenuate the disease condition. Root and tuber phytochemicals have demonstrated anticancer effects in several types of carcinoma cell lines and animal models [46].

Conclusion

Many root and tuber crops are grown throughout the world in hot and humid regions for their use as vegetable as most of them contain starch as the major carbohydrate in them. They are important diet component for human and add variety to it. Taro (colocasia esculenta) is one of the staple root and tuber crop grown for various purposes. Taro tubers provide a numbers of desirable nutritional and health benefits such as anticancer activity, phenolic acid, phytochemicals. In this review there is a important information about taro nutritional importance and the some of the health benefits of taro corms and leaves. Taro is used as a staple food or subsistence food by millions of people in many of the developing countries. The corms of taro are used as vegetable and consider as a rich source of carbohydrates, proteins, minerals, and vitamins. Taro tubers contain 70 to 80 per cent of starch in them. It contains small granules which are highly digestible. Taro can be grown as a root crop, as a leafy vegetable, as an ornamental and as medicinal plant. It is a staple crop for many of south-eastern Asia. Taro is an emergent aquatic and semi-aquatic plant. The leaves of taro are consumed as sauces, purees, stews and soups.

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