

Nutraceutical value of tropical tuber crops

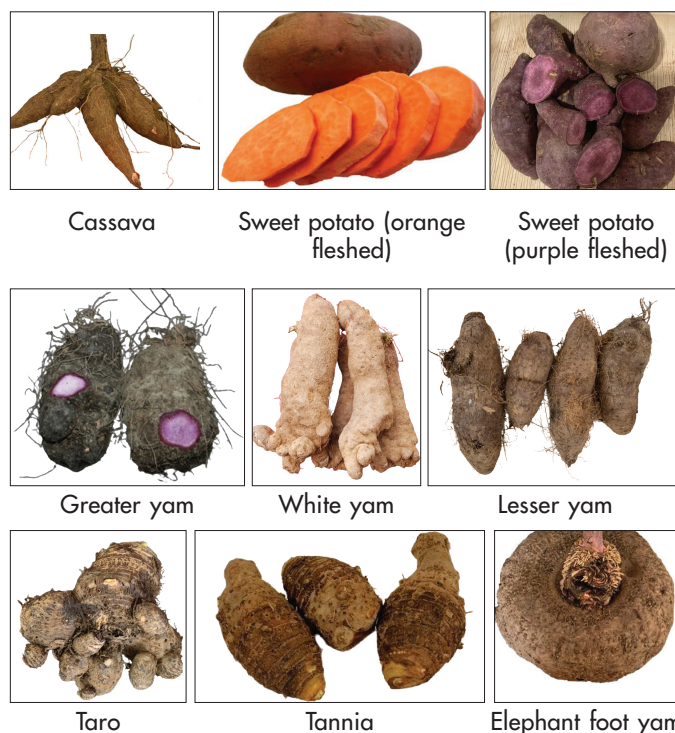
Tropical root and tuber crops viz., cassava, sweet potato, yams, taro, tannia, elephant foot yam, and minor species like arrowroots are vital for food security, nutrition, and income in developing countries. Rich in carbohydrates, vitamins, minerals, and bioactive compounds, they offer both dietary energy and health-promoting benefits. Orange and purple-fleshed varieties provide β -carotene and anthocyanins that help combat vitamin A deficiency and oxidative stress. Phytochemicals from yams, aroids, and minor tubers exhibit antioxidant, anti-inflammatory, and hypoglycemic activities. The growing recognition of these nutritional and functional benefits highlights the potential of tropical tuber crops in combating malnutrition and lifestyle-related diseases while fostering value addition and livelihood security.

Keywords: Aroids, Bioactive compounds, Cassava, Functional foods, Sweet potato, Yams, Traditional medicine

TROPICAL root and tuber crops are ranked as the third most important crops following cereals and grain legumes. They play a vital role in agriculture, food security and income generation for approximately 2.2 billion people in developing countries. They are especially valuable for household food security due to their high biological efficiency and exceptional dry matter production per unit area per day, among the highest of all crops. These crops are also rich in essential micronutrients, including vitamins, minerals, antioxidants and various bioactive compounds. Root and tuber crops offer significant potential for crop diversification and value addition, opening new avenues for both domestic innovation and international trade. In the context of climate change, the high calorific and nutritional values position them as promising crops for future strategies to combat hunger, malnutrition, and poverty. In addition to being excellent sources of carbohydrates, these crops also contain important nutraceutical components such as flavonoids, alkaloids, anthocyanins, glycolipids, triterpenes, and soluble phenolics. Varieties with orange or yellow flesh are rich in beta-carotene and anthocyanins, which can help prevent night blindness and other forms of malnutrition. Certain tuber crops such as elephant foot yam, Curcuma species, and Chinese potato are known for their medicinal properties and are used in traditional medicines. The leaves of many tuber crops provide valuable nutrients, including protein, iron, calcium, and vitamins, and are a significant source of beta-carotene, contributing significantly to the daily requirement of vitamin A.

The major tropical tuber crops are cassava (*Manihot esculenta* Crantz), sweet potato (*Ipomoea batatas* (L.) Lam.), yams (*Dioscorea* L.), taro (*Colocasia esculenta* (L.) Schott),

tannia (*Xanthosoma sagittifolium* (L.) Schott) and elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson). Among the various *Dioscorea* species, the most commonly consumed edible yams are *D. alata* (greater yam), *D. esculenta* (lesser yam), and *D. rotundata* (white yam). In addition to these major crops, several minor tuber crops are also cultivated, such as Chinese potato (*Plectranthus rotundifolius* Poir), yam bean (*Pachyrhizus erosus*), West



Major tropical tuber crops

Indian arrowroot (*Maranta arundinacea* L.), East Indian arrowroot (*Curcuma angustifolia*), and Queensland arrowroot (*Canna edulis*). Three species of yam bean, *P. erosus* (jicama or Mexican yam bean), *P. tuberosus* (jiquima, chuín or Amazonian yam bean) and *P. ahipa* (ahipa), are cultivated. Among these, *P. erosus* is the most widely grown in India.

NUTRITIONAL VALUE

Cassava

Cassava (tapioca) is a major root crop cultivated and utilized by around 102 countries of the tropical and sub-tropical regions of the world. Cassava bags the fifth position globally for its importance as a significant food crop after maize, rice, wheat, and potato. Its starchy tuberous roots serve as a staple for over 800 million people. The major biochemical constituent in cassava is the storage carbohydrate, starch, which constitutes up to 65-70% of the dry matter. The tubers contain sugars, minerals, vitamins, fat, fibre and protein in very low quantities. Cassava roots are high in potassium, calcium and vitamin C. One hundred grams of fresh raw cassava tubers provide about 8% of the recommended dietary allowance (RDA) for energy and approximately 29% of the RDA for carbohydrates in healthy adults. In contrast, their contribution to protein (2.6-3.2% of RDA) and fat (about 1% of RDA) is minimal. Cassava is, however, a good source of vitamin C, supplying 22-26% of the daily requirement. Certain cultivars with cream or yellow flesh contain appreciable amounts of β -carotene. The varieties *Sree Vijaya* and *Sree Swarna*, developed by ICAR-Central Tuber Crops Research Institute (CTCRI), are early-bulking types that produce yellow-fleshed tubers within 6-7 months of planting.

Cassava tubers contain the antinutritional compounds called cyanogenic glucosides, which are hydrolyzed by linamarase enzyme to acetone cyanohydrin, and then release toxic hydrogen cyanide. These glucosides impart bitterness to fresh tubers. Sun drying, boiling in excess water, flour preparation, fermentation, etc., are some of the processing methods to effectively remove these

antinutrient factors.

Sweet potato

Sweet potato has gained prominence in recent years as a health food owing to the diverse bioactive compounds present in its tubers. The tubers uniquely combine the qualities of cereals, fruits, and vegetables through their richness in starch, pectin, and vitamins, respectively. The dry matter varies from 25.1-38.2% and starch comprises 50-80% of the dry matter. Raw tubers contain 2.19-5.0% sugars, mainly sucrose, glucose, fructose and maltose. Sweet potato is a good source of non-starch polysaccharides, viz., cellulose, hemicellulose and pectins, which together function as dietary fibre and play a significant role in the prophylaxis of various diseases such as colon cancer, diabetes mellitus, cardiovascular diseases, hypercholesterolaemia and obesity. When included in the diet, the bioactive compounds in sweet potatoes may offer physiological and metabolic benefits, such as reducing the risk of cardiovascular disease, asthma, type 2 diabetes, and certain cancers. One hundred grams of sweet potato provides about 4.3% of the recommended dietary allowance (RDA) for energy, 15% for carbohydrates, 13-16% for vitamin C, and 17% for vitamin B6 in healthy adults.

The tuber flesh colour varies widely, ranging from white to deep orange and purple. Orange fleshed sweet potato is a good source of beta carotene, an essential antioxidant factor of food capable of reducing the risk from night blindness and certain types of cancer. The total carotenoids in cream, yellow and orange fleshed tubers range from 0.013 to 14 mg/100 g fresh wt. of tubers. Hundred grams of orange fleshed sweet potato tubers give about 8,509 μ g of β -carotene and 14,187 IU of vitamin A. The purple fleshed sweet potatoes are a good source of anthocyanins, the polyphenolic compounds known for their medicinal value as antioxidants and cancer preventing agents. Sweet potato anthocyanins have multiple physiological functions including radical-scavenging, anti-mutagenic, hepato-protective, anti-hypertensive, and antiproliferative activity against various human cancer cells.

Proximate composition and nutritional profile of tropical tuber crops (100 g fresh tuber)

Principle	Unit	Cassava	Sweet potato	Greater yam	Taro	Elephant foot yam
Food energy	kcal	150-200	86.0-90.0	82.3-118.0	112-135	90-116
Proximate composition						
Moisture	g	64.8-85.3	62.0-75.0	62.0-72.5	72.5-80.5	71.1-79.0
Dry matter	g	29.8-39.3	25.1-38.2	23.52-28.20	13.0-29.0	21.0-28.9
Carbohydrates	g	25.3-39.0	18.0-28.0	24.7-31.0	1.13-1.75	10-24
Protein	g	0.2-1.5	1.3-1.6	1.44-1.83	0.10-0.14	1.2-1.5
Fat	g	0.15-0.5	0.40-0.70	0.07-0.10	1.03-1.27	0.05-0.40
Starch	g	24.0-38.0	16.0-25.0	17.5-21.5	9.6-19.0	11.0-20.5
Sugar	g	0.9-1.3	2.19-5.0	0.5-1.4	1.95-2.27	1.12-1.60
Fibre	g	0.08-0.50	1.8-3.0	1.71-1.83	0.89-1.20	0.80-1.41
Ash	g	0.4-1.7	1.5-2.7	1.2-2.1	1.01-1.24	0.80-1.85
Mucilage		-	-	1.3-2.0		

Principle	Unit	Cassava	Sweet potato	Greater yam	Taro	Elephant foot yam
Vitamins						
Thiamine	mg	0.03-0.28	0.03-0.28	0.036-0.21	0.085-0.095	0.05-0.10
Vitamin B6	mg	0.05-0.1	0.05-0.1	0.25-0.57	0.088-0.283	0.250-0.272
Riboflavin	mg	0.03-0.06	0.03-0.06	0.08-0.13	0.025-0.035	0.02-0.07
Niacin	mg	0.60-1.09	0.60-1.09	0.50-0.55	0.60	0.8-1.5
Vitamin C	mg	15-50	15-50	13.0-25.0	3.5-7.0	3.5-8.0
Vitamin A	µg RAE (Retinol Activity Equivalent)	-	675	-	-	-
Total carotenoids	mg	-	0.05-14.0	-	-	-
Minerals						
Phosphorus	mg	9-40	9-40	54-117	53-92	50-68
Calcium	mg	32-55	32-55	11.3-14.0	67-90	46-84
Magnesium	mg	18-27	18-27	23.1-30.0	10-17	21-23
Iron	mg	0.20-0.35	0.20-0.35	0.13-0.22	0.86-1.5	1.4-1.7
Manganese	mg	0.02-0.08	0.02-0.08	0.11-0.30	0.7-1.3	0.46-0.84
Zinc	mg	0.12-0.24	0.12-0.24	0.52-0.86	0.7-2.3	1.0-1.3
Potassium	mg	98-326	98-326	72-141	253-460	237-288
Sulphur	mg	30-38	30-38	-	-	-
Copper	mg	-	0.03- 0.06	-	-	-

Edible yams

The major edible yams are greater yam, white yam and lesser yam. Starch constitutes the major carbohydrate in all the three edible species of *Dioscorea* (Yams) which range from 17.5-23.8% on fresh wt. basis. Yam tubers contain essential micronutrients and phytochemical compounds such as iron, zinc, vitamin C, carotenoids, polyphenols and flavonoids. Several physiological effects including lowering of lipid and sugar levels in blood, antioxidant activity, anti-mutagenic activity and anti-allergic activity have been reported in yam extracts due to the presence of phenolic phytochemicals. The tubers are an important source of hydrocolloid in the form of mucilage. Mucilages are bioactive water-soluble polysaccharides possessing anti-tumour, anti-inflammatory, immune-modulatory and antioxidant activities. The tubers also contain alkaloids, tannins, saponins, glycoside steroids, and anthraquinones, which have various pharmacological activities. Purple fleshed cultivars of greater yam contain anthocyanins have antioxidant and antiproliferative activities. Certain species of yams are used as medicine in East Asian countries to prevent diarrhea and diabetes. Hundred grams of yam tuber provide about 21% of RDA for carbohydrates, 3-4% for protein, 19-22% for vitamin C and 14% for vitamin B6.

Aroids

Aroids are important starchy tuber crops valued for their nutritional and medicinal properties, serving as vital food security crops in tropical regions such as West Africa, Southeast Asia, the Pacific Islands, Papua New Guinea, and the Caribbean. The major edible species include taro, *tannia*, and elephant foot yam. In taro and *tannia*, all plant parts are edible, whereas in elephant foot yam, the corms and petioles are primarily consumed. Taro alone is a dietary staple for nearly 400 million

people, particularly in the humid tropics. The mucilage component of taro cormels is important from the health point of view, imparting properties such as slow transit of food through upper GI tract, hold moisture to prevent constipation and lower blood cholesterol by binding bile. Taro cormels (100 g) provide about 20% of the RDA for carbohydrates, 10.8% for dietary fibre, 16% for vitamin B6, and 10.6-12.6% for vitamin C. They also contribute 8-15% of the daily iron requirement in healthy individuals. Tannia cormels supply approximately 18% of the RDA for carbohydrates, 3-4% for protein, 14% for vitamin B6, and 10-12% for vitamin C.

In many states of India, tannia leaves are used as a leafy vegetable. In Gujarat, tannia crop is grown throughout the year mainly for leaf purpose. In Gujarat and some parts of Maharashtra it is used for making a value-added product called 'Paatra' and the *subji* of 'Turiya-patra' in marriage season. The leaves can be used as vegetable after boiling just like spinach. A variety of *tannia*, *Navsari Pari* has been recently recommended for release in Gujarat exclusively for leaf purpose. The leaves of taro and *tannia* contain significant amounts of protein, beta-carotene, vitamins and minerals.

Elephant foot yams have a unique and rich nutritional profile and offer a number of significant health benefits. The edible corm finds use as a vegetable and is also an ingredient of several Ayurvedic preparations due to its medicinal and health benefits. Apart from carbohydrates, the corm is a good source of phytochemical compounds such as flavonoids and polyphenols, vitamins and minerals. The aqueous extract of elephant foot yam contains flavonoids and tannins contributing to health effects, especially antioxidant activity. Hundred grams of elephant foot yam tuber can provide 13% of daily requirement of carbohydrates, 2.5-3% of protein, 10% of

dietary fibre, 16% of vitamin B6 and 7-9% of vitamin C.

Oxalates are the major limiting factor in the utilization of aroids which impart acid taste or cause irritation when raw or unprocessed foods from them are eaten. Processing methods such as peeling, washing, dicing, soaking, blanching, drying and fermentation help to reduce the calcium oxalate content.

Minor tuber crops

In addition to the major tropical tuber crops, several minor tubers are cultivated in localized regions across the world. Notable examples with nutritional potential include Chinese potato (Country potato or Hausa potato), West Indian arrowroot, East Indian arrowroot (*Tikhur*), Queensland arrowroot (Canna or Achira), Yam bean and *Curcuma* species. These crops are valuable sources of secondary metabolites such as terpenoids, steroids,

glycosides, saponins, flavonoids, phenolics, alkaloids, and tannins, many of which possess therapeutic and pharmaceutical applications. Their high levels of phenolic and flavonoid compounds contribute significantly to the antioxidant properties of the tubers. The terpenoid compounds present in most of these minor tubers have antioxidative, anti-inflammatory, wound-healing, hypoglycemia, anticoagulant, and antimicrobial activities.

Arrowroot starch is popular for its high digestibility and medicinal properties. It possesses demulcent properties that soothes and protects irritated or inflamed internal tissues of the body and hence is given in bowel complaints. Arrowroot starch is used for stomach and intestinal disorders, including diarrhoea. The *tikhur* starch can be used in the diet of children due to easy digestibility like arrowroot starch. The rhizomes are ground into a flour which can then be mixed together with milk or water to form a nutritious meal.

It is an excellent diet in case of dysentery, dysuria and gonorrhoea, etc. The tuberous roots of yam bean contain both starch and sugar and are a moderately good source of vitamin C. The young tubers are eaten raw in salads, or cooked as a vegetable, or in pickles and chutney.



Arrowroot



Chinese potato



Yam bean



Canna (Achira)



Tikhur



Curcuma zedoaria
(zedoary, white turmeric or Kachur)

CONCLUSION

Root crops are essential components of the diet of people in many countries, especially in the tropical countries. Root crops have the potential to provide more dietary energy per hectare than cereals. Apart from being rich source of carbohydrates, many root and tuber crops are also potential sources of nutritional components such as minor nutrients, dietary fibre, and bioactive phytochemicals such as carotenoids, flavonoids, and phenolic compounds. These crops offer immense potential not only for meeting nutrient requirements but also as health protectants and therapeutics. By exploring these possibilities, India can revitalize tuber crop cultivation, improve the livelihoods of farmers, and add significant value to these crops.

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