



## Recent Advances and Potentials of Tuber Vegetable Crops

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Starchy tuber crops play a pivotal role in the human diet. There are number tubers crops which make an extensive biodiversity even within the same geographical location. Thus, they add variety to the diet in addition to offering numerous desirable nutritional and health benefits such as antioxidative, hypoglycaemic, hypocholesterolaemia, antimicrobial, and immunomodulatory activities. A number of bioactive constituents such as phenolic compounds, bioactive proteins, glycoalkaloids, and phytic acids are responsible for the observed effects. In Asian countries, some edible tubers are also used as traditional medicinal. A variety of foods can be prepared using tubers and they may also be used in industrial applications. Processing may affect the bioactivities of constituent compounds. Tubers have an immense potential as functional foods and nutraceutical ingredients to be explored in disease risk reduction and wellness.

**Key words:** Tuber crops, Nutrition value, Cassava, Potato, Tannia, Bioactive compound

### Introduction

Tuber Crops are the most important food crops after cereals. They have the highest rate of dry matter production per day and are major calorie contributors. Tuber crops find an important place in the dietary habits of small and marginal farmers especially in the food security of tribal population of Indian subcontinent. The crops widely recognized as important food security crops, offer adequate calories and nutrition for around 500 million people of the tropical belt. Tuber crops not only enrich the diet of the people but also possess medicinal properties to cure many ailments or check their incidence. Many tropical tuber crops are used in the preparation of stimulants, tonics, carminatives and expectorants. The tuber crops are rich in dietary fibre and carotenoids such as carotene and anthocyanin. India holds a rich genetic diversity of tropical root and tuber crops viz. Cassava, Sweet potato, Aroids, Yams and several minor tuber crops. The Indo-Burma region is the centre of origin of taro and Asiatic edible yams. The two hot spots of global biodiversity viz. North Eastern Himalayas and Western Ghats are particularly rich in wild relatives of tropical root and tuber crops. Safe conservation and sustainable use of plant biodiversity is essential for meeting the present and future needs of tuber crop improvement in India. Besides food value, the tropical root crops like cassava and sweet potato are of relevance for industrial uses like starch, dextrin's, alcohol, high fructose syrup, noodles, sago and liquid glucose. Cassava and sweet potato account for about 30% of the total production of root crops from the developing countries. Whilst yams are important crops for the African continent, taro and tannia are of much significance in the food pattern of the people of Fiji, Western Samoa etc. Minor root crops like elephant foot yam and Chinese potato are highly valued as vegetables, while arrowroot, despite the inherent problems of starch extraction due to the fibrous nature of the tubers, is a much-valued root crop for the production of starch.

Table 1: Nutritional composition of selected tuber crops.

Nutrients (100 g)	Potatoes		Sweet potato	Cassava	Yam
	White flesh	Red flesh			
<b>Proximate composition</b>					
Energy (kcal)	69.0	70	86.0	160.0	118.0
Protein (g)	1.7	1.9	1.6	1.4	1.5
Total lipid (fat) (g)	0.1	0.1	0.1	0.3	0.2
Carbohydrate,	15.7	15.9	20.1	38.1	27.9
Fibre, total dietary (g)	2.4	1.7	3.0	1.8	4.1
Sugars, total (g)	1.2	1.3	4.2	1.7	0.5
<b>Minerals</b>					
Calcium, Ca (mg)	9	10	30	16	17
Magnesium, Mg (mg)	21	22	25	21	21
Potassium, K (mg)	407	455	337	271	816
Phosphorus, P (mg)	62	61	47	27	55
Sodium, Na (mg)m	16	18	55	14	9
<b>Vitamins</b>					
Total ascorbic acid (mg)	19.70	8.60	2.40	20.60	17.10
Thiamin (mg)	0.07	0.08	0.08	0.09	0.11
Riboflavin (mg)	0.03	0.03	0.06	0.05	0.03
Niacin (mg)	1.07	1.15	0.56	0.85	0.55
Vitamin B-6 (mg)	0.20	0.17	0.20	0.088	0.293
Folate ( $\mu$ g-DFE)	18	18	11	27	23
Vitamin E (mg)	0.01	0.01	0.26	0.19	0.35
Vitamin K ( $\mu$ g)	1.6	2.9	1.8	1.9	2.3
Vitamin A (IU)IU	8	7	14187	13	138

Source: USDA

### Different types of tubers crop commonly consumed in world:

1. **Potatoes (*Solanum tuberosum*):** Potato is currently the fourth most important food crop in the world after maize, wheat, and rice, with a production of 368 million tonnes. It ranks the third after rice and wheat in terms of consumption. Potato is a crop of highland origin and has been domesticated in the high Andes of South America. The energy intake from potatoes by an individual in developed and developing countries was 130 and 41 kcal/day, respectively. Potatoes provide significant amounts of carbohydrates, potassium, and ascorbic acid in the diet. Furthermore, they contribute to 10% of the total folate intake in some European countries, such as Netherlands, Norway, and Finland. In addition, ascorbic acid present in potatoes protects folates from oxidative breakdown. About 50% of the recommended dietary allowance (RDA) of vitamin A may be provided by 250 g of genetically carotenoid enriched potatoes.
2. **Sweet Potatoes (*Ipomoea batatas* L.):** The origin of sweet potato is Central America, but at present it is widely grown in many tropical and subtropical countries in different ecological regions. Sweet potato can be grown all around the year under suitable climatic conditions and complete crop loss under adverse climatic conditions is rare; thus, it is considered as an “insurance crop.” Sweet potatoes are considered as a typical food security crop for disadvantaged populations as the crop can be harvested little by little over a long period of time. National Aeronautics and Space Administration (NASA) has selected sweet potatoes as a candidate crop to be grown and incorporated into the menus for astronauts on space missions due to their unique features and nutritional value (A. C.

Bovell-Benjamin. 2007). The consumption of 125 g orange fleshed sweet potatoes, rich in carotenoids, improves vitamin A status of children, especially in developing countries (P. J. van Jaarsveld. *et. al.* 2006).

3. **Cassava (*Manihot esculenta*):** Cassava is the most widely cultivated root crop in the tropics and because of long growth season (8–24 months), its production is limited to the tropical and subtropical regions in the world. The genus *Manihot* comprises 98 species and *M. esculenta* is the most widely cultivated member. Cassava plays an important role as staple for more than 500 million people in the world due to its high carbohydrate content. A number of bioactive compounds, namely, cyanogenic glucosides such as linamarin and lotaustralin, noncyanogenic glucosides, hydroxycoumarins such as scopoletin, terpenoids, and flavonoids, are reported in cassava roots.
4. **Yams (*Dioscorea* sp.):** Yam is a member of the monocotyledonous family Dioscoreaceae and is a staple food in West Africa, Southeast Asia, and the Caribbean regions. Yam is consumed as raw yam, cooked soup, and powder or flour in food preparations. Yam tubers have various bioactive components, namely, mucin, dioscin, dioscorin, allantoin, choline, polyphenols, diosgenin, and vitamins such as carotenoids and tocopherols. Mucilage of yam tuber contains soluble glycoprotein and dietary fibre. Several studies have shown hypoglycaemic, antimicrobial, and antioxidant activities of yam extracts. Yams may stimulate the proliferation of gastric epithelial cells and enhance digestive enzyme activities in the small intestine.
5. **Aroids:** Aroids are tuber or underground stem bearing plants belonging to the family Araceae. There are several edible tubers/stems such as taro (*Colocasia*), giant taro (*Alocasia*), tannia or yautia (*Xanthosoma*), elephant foot yam (*Amorphophallus*), and swamp taro (*Cyrtosperma*).
6. **Minor Tuber Crops:**
  - a. Yam bean: popularly known as potato bean and mishrikand.
  - b. Arrowroot
  - c. Jerusalem artichoke: It is commercial source of levulose used as sweetening agent by diabetic patients.
  - d. Coleus: it is known as Chinese potato or koorka.
  - e. Giant taro
  - f. Chinese water chestnut: perennial leafless sedge commonly found in marshes and swams through the world.

### Bioactive Compounds in Tuber Crops

Bioactive compounds in plants are secondary metabolites having pharmacological or toxicological effects in humans and animals. Secondary metabolites are produced within the plants besides the primary biosynthesis associated with growth and development. These compounds perform several essential functions in plants, including protection from undesirable effects, attraction of pollinators, or signalling of essential functions. Different bioactive compounds: Phenolic compounds have an aromatic ring with one or more hydroxyl groups and act as antioxidants. They are derived from biosynthetic precursors such as pyruvate, acetate, a few amino acids, acetyl-CoA, and malonyl-CoA following the pentose phosphate, shikimate, and phenylpropanoid metabolism pathways. Bioactive Proteins. The protein contents of roots and tuber crops are variable. The global contribution of proteins from roots and tubers in the diet is less than 3%. However, in African countries, this contribution may vary from 5 to 15%. Dioscorin is the main storage protein found in tropical *Dioscorea* yams. It accounts for 90% of water extractable soluble proteins in a majority of *Dioscorea* species. Sporamin is a soluble protein and is the main storage protein in sweet potato roots and accounts for about 60–80% of its total proteins. The sporamin of sweet potatoes is initially known as ipomoein.



## Bioactivities of Phytochemicals in Roots and Tubers

1. **Antioxidant Activity:** Accumulating research evidences demonstrate that oxidative stress plays a major role in the development of several chronic diseases such as different types of cancer, cardiovascular diseases, arthritis, diabetes, autoimmune and neurodegenerative disorders, and aging.
2. **Antiulcerative Activities:** Kim *et al.* showed that butanol fraction of sweet potato could be a better source for treating gastric ulcers induced by excessive alcohol intake.
3. **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. Huang *et al.* (2012) showed that aqueous extract of sweet potatoes had higher antiproliferative activity than that of ethanol extracts. purple fleshed potato showed higher potential in suppressing proliferation and elevated apoptosis of HT-29 human colon cancer cell lines compared with white fleshed potato.
4. **Antimicrobial Activity:** Yam varieties with their phenolic compounds are potential agents with antimicrobial efficacy.
5. **Hypoglycaemic Activities:** Diabetes mellitus is a chronic disorder marked by elevated levels of glucose in the blood and life-threatening complications that can untimely lead to death. Extracts of sweet potato peels have shown reduced plasma glucose levels of diabetic patients. Ethanol extract of tubers of *Dioscorea alata* showed an antidiabetic activity.
6. **Hypo cholesterolemic Activity:** Cardiovascular diseases are among the leading causes of death worldwide. It is well known that diet plays an important role in the regulation of cholesterol homeostasis. Diosgenin, a steroidal saponin of yam (*Dioscorea*), demonstrated antioxidative and hypolipidemic effects *in vivo*.

## Conclusion

Roots and tubers are important diet components for humans and add variety to it. In addition to the main role as an energy contributor, they provide a number of desirable nutritional and health benefits such as antioxidative, hypoglycemic, hypocholesterolemic, antimicrobial, and immunomodulatory activities. A variety of foods can be prepared using tubers and type and usage vary with the country and region. Processing affects the bioactivities of constituent compounds. Tubers may serve as functional foods and nutraceutical ingredients to attenuate noncommunicable chronic diseases and to maintain wellness.

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