SOME EDIBLE RHIZOMATOUS AND TUBEROUS CROPS OF INDIA

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Many types of rhizomatous and tuberous crops are found in different parts of India. Most of them are not indigenous and have been brought to this country from South America, North America or Malaya. Although all of them are not used as food, there are quite a number which can be profitably utilized as food. In the present context of rapid increase of population and consequent shortage of food grains in India, improvement and increased production of various types of tuberous crops as food supplementing the cereals are considered very essential. In view of this, a survey has been made on the wild and cultivated rhizomatous and tuberous crops of India other than potato which can be used as food in supplementing cereals. An account of such crops is briefly presented in this article. Such root tubers as turnip, beet, carrot and radish which are mostly used as vegetables have not been dealt with here.

ALOCASIA

Alocasia belonging to the family Araceae is a genus of herbs bearing short succulent rhizomes or rootstocks with large leaves. There are about 65 species distributed in tropical Asia of which 12 are found in India. Of these *A. cucullata* Schott., *A. indica* (Roxb.) Schott and *A. macrorrhiza* Schott are cultivated for their edible rootstocks. The rhizomes of *A. fornicata* Schott found in village shrubberies are often eaten by poorer classes of people.

Of the three cultivated species, *A. indica* is most important. It is a tall aroid with an underground rhizome bearing a succulent swollen stem, 10-20 cm in diameter and about 30 to 60 cm or more in length. It is cultivated in many parts of India, particularly in Assam and Bengal and is widely used as a vegetable. When the rootstock is pulped and washed, it yields a pure white starch. The flour, obtained is a light and nutritious food suitable for invalids. It is more or less mucilaginous and is more easily digestible than rice.

AMORPHOPHALLUS

The genus *Amorphophallus* belonging to the family Aroideae has about 90 species of perennial or biennial herbs usually bearing one broad, long petioled leaf. All the species bear corms. In India there are only 14 species, of which *A. campanulatus* Blume is the only edible species. It is cultivated throughout India and Ceylon. The underground corm is more or less hemispherical or sometimes somewhat elongated, 20 to 30 cm or more in diameter and is of a dull brown or yellowish brown colour. The corms usually weigh from 1 to 2 kg and sometimes as high as 5 to 10 kg in some parts of Bombay. The tuberous outgrowths from the fully developed corms are planted during May and June. Not much care is needed after planting. They mature in about 10 to 12 months when they can be dug out.

Usually pieces of corms are boiled in water and eaten with rice as such as boiled potatoes or in curries.

CANNA EDULIS

It is a handsome rhizomatous perennial herb, a native of Tropical America and is cultivated in various parts of the tropics for the tuberous edible rhizomes from which a kind of arrowroot starch is produced. The plants can grow on most types of soils, and under favourable conditions heavy yields of rhizomes are obtained. The tubers and tops of plants are used as stock-feed and the starch is used as a food for children and invalids.

CASSAVA OR TAPIOCA

Manihot esculenta Crantz (syn. *M. ulilissima* Pohl.), commonly known as Cassava or Tapioca, is a low shrubby plant with a cluster of tuberous roots. It is a native of South America from where it has been introduced to India, Africa and S. E. Asian countries. In India cassava is grown as a subsidiary food crop mainly in the States of Kerala and Madras, where the area is roughly about 500,000 acres. In respect to acreage, it ranks second in importance among the tuber crops of India.

Since the beginning of World War II when supplies of rice from Burma and starch from western countries were very much disturbed, cassava was considered as an important crop in India and had been tried in many other States besides Kerala and Madras, but unfortunately it did not find much favour with the people of most areas.

Cassava has several varieties and for edible purposes, strains with high starch and protein content and little or no hydrocyanic acid are usually cultivated. Cassava prefers a warm, humid climate with ample rainfall. It does not stand frost and usually cannot be grown above an altitude of 900 m. A fairly well-spread rainfall of about 150 cm is considered to be optimum for the growth of the crop.

In India cassava is usually grown as a pure crop, but it can be grown as a mixed crop with vegetables, banana or sweet potato. In Brazil the writer has seen cassava grown as a mixed crop with high land paddy. Such trials should be undertaken here.

Cassava is propagated by cuttings of stems after the advent of monsoon. After the field has been thoroughly prepared with the application of a basal dressing of farm yard manure, small pits are dug up to seven to eight cm. apart in which the cuttings are planted in a vertical position one in each pit. Fertilization of the soil by the application of organic manures and or inorganic fertilizers is necessary, as cassava is an exhaustive crop.

The yield of tubers under Indian conditions varies from 1 to 12 tons per acre. In trial under intensive cultivation in Kerala, yields up to 20 tons have been obtained.

COLEUS PARVIFLORUS

It is a small herbaceous annual, 1–2 ft high with succulent stem and

aromatic leaves. It bears a cluster of dark brown tuberous roots. The plant is grown in India, Ceylon, Java, Indo-China and parts of tropical Africa for the small edible tubers which are used as a substitute for potato. In India, it is usually grown in the south, particularly in the Malabar Coast. The plants are propagated generally by suckers obtained from germinating tubers. The suckers are planted with the onset of rains in May/June and harvested in December/January. The plants are almost free from pests and diseases. The average yield is about 2000 to 2500 kg per acre but under suitable conditions yields as high as five to six tons can be obtained. The tubers which are small and blackish brown in colour, are starchy with an aromatic flavour. They have a sweetish taste and are used in the same way as potato in curries and in other preparations.

COLOCASIA

Colocasia is a small genus of 13 species of perennial herbs of which five to six are reported from India. Only one species *C. esculenta* (Linn) Schott* a plant considered to be a native of S. E. Asia, is extensively cultivated in India. It is a very variable perennial rhizomatous plant with large heart-shaped leaf blades borne on long petioles 30 to 200 cm high. Numerous varieties are known, differing in the colour of leaf blades and petioles and the size, shape, colour, palatability and nutritive value of the tubers. Two principal groups can be differentiated, one with deep purple laminas and petioles and the other in which these parts are green. The sizes of tubers vary considerably in different varieties from small, roundish ones, 2–4 cm in diameter to big and elongated tubers 15 cm in diameter and up to 60 cm in length. The flesh of the rhizomes vary from white to yellow or orange to red or purple.

The plant is propagated by suckers or corm tops or branch tubers. These are planted 8 to 12 cm deep in rows 30 to 60 cm apart with gaps 20 to 30 cm in each row. The method of planting varies according to variety and locality. The usual planting period is from February to July, although it can be planted throughout the year. Manuring is usually done with cow-dung or with mixtures of chemical fertilizers wherever available. The crop has a growing period of four to eight months, depending on the variety used. During this period, weeding is done by occasional hoeing. The crop is harvested when the leaves begin to turn yellow. The tubers are either pulled out by hand or dug up with a spade. After cleaning, the main corms are separated out from the side ones. The yield varies considerably. It may be as low as 1000 kg per acre or as high as 8000 kg under favourable conditions.

The rhizomes are very rich in starch and are used in the same manner as potato. They are somewhat sweeter and more easily cooked than potatoes. They can also be used as fried chips in the same manner as potatoes. The flesh has a delicate, nutty flavour when cooked and is more nutritious than potato, being richer in carbohydrates and proteins. It is also a good source of calcium and phosphorus. When steamed the rhizomes contain 30% starch and 3% sugar and becomes an energy giving good food. In such condition this is liked very much by the people of Northern India.

CURCUMA

This is a genus of 70 species of rhizomatous herbs distributed in India, Siam, Malaya, Archipelago and N. Australia. About 30 species occur in India

of which only two, *C. angustifolia* and *C. zedoaria*, are useful in the production of starch.

C. angustifolia Roxb. — The plant usually grows wild in many places but is also cultivated in some areas particularly in the southern parts of India. Yield of about 2000 kg per acre has been reported from trials conducted in Madras. Starch usually prepared from the tubers, resembles arrowroot starch to some extent and is easily digestible. It is used in the preparation of milk puddings and is suitable for children and invalids.

C. zedoaria Rosc. — The plant, a native of N. E. India, is widely cultivated in many parts of Ceylon and China for the production of a kind of starch commercially known as *'shoti'*. The plant grows to a height of about 1½ ft and bears green leaves with brownish purple veins. The rhizomes are large and fleshy. The *shoti* starch is a product extracted from the rhizomes and is used as a substitute for arrowroot and barley. It is highly valued as an article of food especially for infants and convalescents. It is also occasionally used in confections.

DIOSCOREA

Dioscorea is a very large genus of annual twining herbs. Of the 50 species found in India only a few are cultivated for their edible tubers which are called 'yams'. The genus has been classified by Prain and Burkill into two broad divisions: (i) those with stems twining to the right and (ii) those with stems twining to the left. There are about seven edible species in India out of which *D. alata* Linn., *D. glabra* Roxb. and. *D. oppositifolia* Linn. come under the former group and *D. bulbifera* Linn., *D. esculenta* Burkill, *D. pentaphylla* Linn., and *D. hispida* Dennst. come under the second group. The edible *Dioscoreas* are cultivated mostly as garden crops or as subsidiary crops with ginger, turmeric, sweet potato or maize.

They grow well in sandy loam soil with proper drainage facility. As the crop is exhaustive, the field is manured liberally with farmyard manure. Both underground tubers and aerial tubers (bulbils) borne in the axils of leaves are used for propagation. These are usually planted from April to July with the onset of first showers of rain. The vines may be allowed to grow on the ground or are trailed over stakes or they may twine on trees nearby. The yield of tubers is usually higher when they are allowed to grow on stakes or on trees. The crops mature in five to eight months time. During this period, the field is hoed and weeded and irrigated whenever necessary. When the tubers are fully developed, the leaves dry up. At that time, the stems are cut and the tubers dug out. The tubers are very variable in size and shape. They are either solitary, one on each plant, or a number of them are clustered together at the base of the plant. The yield of the tuber is also very variable and depends on the variety cultivated and on the soil and cultural treatments. Yields of the two important species are as follows :—

(i) *D. alata*: 2.5 to 14 tons with an average of 7 tons per acre.

(ii) *D. esculenta*: 5 to 11 tons with an average of 8 tons per acre.

Wherever the tuber is solitary, a single tuber may weigh from 2 kgs to 20 kgs. The tubers are comparable to potato in taste and in quality and are used

in the same way as potato. They form a cheap source of carbohydrate food and are extensively used by the hill tribes in the uncultivated tracts of certain parts of India. They are of great value during periods of scarcity of cereals.

Starch is extracted on a commercial scale from the tubers of *D. alata.* Some tubers are used for alcohol production. They are poor in protein, calcium and iron content, but they are rich in vitamins of the B group.

Some of the nonedible tubers, as for example, the tubers of *D. deltoidea* Wall. and *D. prazeri* Prain and Burkill, have steroidal saponins which yield diosgenin on acid hydrolysis; the latter forms a starting material for the partial synthesis of sex-hormones and cortisone.

ELEOCHARIS

E. dulcis Trin. *(Syn. E. tuberosa* Schult) belonging to the family Cyperaceae is a stout, leafless sedge bearing a rounded corm or tuber at the base from which a large number of radiating stolons each ending in a corm are developed. The plants are normally found in marshes and moist places almost throughout India up to an altitude of 3000 ft. It is propagated by cuttings and corms. It is more commonly cultivated in China, Japan and Malaya. The tubers are dark brown in colour rounded or onion-shaped, 1 to 1.5 cm in diameter. They are rich in starch and also contain some protein and sugar. They are considered as nutritious and eaten widely. The flesh of the tubers is white and of uniform consistency. They are also cooked and served in salads and soups. They are considered as a delicacy by certain section of people. In India its cultivation is only in small scale and so no yield data are available. A cultivated variety of *E. dulcis* grown in China bears larger tubers (2.5 — 4 cm diam.) and gives a yield up to about 9 tons per hectare.

HELIANTHUS TUBEROSUS

H. tuberosus, a native of North America, and commonly known as Jerusalem artichoke, is an erect hardy perennial crop, which behaves as an annual under cultivation. It is cultivated for its edible tubers, throughout the temperate regions of many parts of the world. In India it is grown in the hill stations at an elevation of 300 to 800 m. but can be grown up to 1300 m. It can, however, be grown under a wide range of soil and climatic conditions. It can also be produced successfully even on lands unsuitable for many other vegetable crops. It is, therefore, possible to extend its cultivation in many newer areas.

The tubers have many varieties and somewhat resemble potatoes, but with larger eyes. From the point of view of food value, the tubers are considered equal to potatoes. They are eaten raw or boiled or as fried chips.

The plant is usually propagated by tubers in well prepared soil liberally manured by farmyard manure or compost. Whole tubers or pieces with two to three eyebuds are planted about six to eight cm deep in rows during March to May in the plains and February to April in the hills. During early stages of dry weather, irrigation is necessary. The crop takes four to seven months to mature. The yield of tubers is from 4 to 10 tons per acre; higher yields have been recorded under favourable conditions.

IPOMOEA BATATAS

I. batatas, the sweet potato; a native of tropical America is being grown for many years in different parts of India and ranks third in importance among tuber crops. Breeding and agronomic works have been carried out in several places for the improvement of the crops. Besides, improved varieties have been obtained from China and U.S.A. Sweet potatoes cultivated in India may be grouped under two main types broadly distinguished by the colour of the tuber coat; they are the white-skinned types and the red-skinned types, the colour of the flesh being white in both. Another type with a golden yellow flesh has been introduced from America in certain areas. Sweet potato is propagated vegetatively by cuttings of the vine obtained from the previous years crop or by sprouts raised from tubers. The former methods is cheaper and is usually practised. The average yield of tubers varies from 4000 to 12,000 kg per acre. Several improved varieties have been evolved by the Indian Agricultural Research Institute. Under proper management such varieties are reported to yield 15,000 kg or more per acre.

Sweet potato is grown more or less in most of the States of India, the total area being about 400,000 acres. It is most extensively grown in the State of Bihar when the area is nearly half of the total Indian acreage.

In India, sweet potato is used as food after boiling, baking or frying and as a vegetable in curries and other preparations. The dried tubers are often ground into flour and mixed with wheat flour for preparing hand-made bread locally known as *'chapati'*. They are also used in various confections.

MARANTA ARUNDINACEA

This is a native of tropical America. As its rhizomes supply the true arrowroot of commerce, its cultivation has spread extensively to many tropical countries including India. In India the area under cultivation is comparatively less. Two types, blue and yellow, called according to the colour of the rhizomes, are usually grown. The yield of starch from the blue type is higher than that of the yellow type.

The plant, grown best in light, well-drained loamy soil, is propagated by means of rhizomes. Planting is done in May. Irrigation is necessary during the growing period. The rhizomes are ready for harvest after about 10-11 months after planting. The yield of rhizomes varies from 4-7 tons per acre, although much higher yields (12 tons) have been recorded under favourable conditions.

The rhizomes are mostly used for production of starch. The true or West Indian arrowroot forms an important ingredient for the preparation of infant foods, biscuits, cakes, puddings etc. They are also eaten boiled and roasted.

PACHYRRHIZUS

This is a tropical American genus consisting of only a few species. One species, *P. erosus* (Linn.) Urban (syn. *P. angulatus* Rich. ex DC) is cultivated in several areas of India for its fleshy tuberous roots. The plant is a native of Mexico and Central America and has now been naturalised in various tropical regions of both the hemispheres.

The plant grows well on light rich sandy loam soils with good arrangements for drainage. The soil should be liberally manured about a month before planting of seeds, by means of which the plant is usually propagated. About 18 to 20 kg of seeds are required for an acre. The seeds are sown usually in June/July at a distance of 30-40 cm in rows which are 60-75 cm apart. The crop reaches maturity in about six to eight months after planting. In order to encourage better development of tubers several pruning operations are undertaken to partially check the vegetative growth. The tubers are obtained before the seed pods mature and at this time the tubers are tender and crisp. The tubers are white in colour and are very variable in size and shape being roundish or lobed, turnip-like or elongated. The tubers sold in market may weigh from about 200 grams to about 1 kg each, but fully developed tubers measuring about 40 cm in diameter and weighing about 5 to 15 kg are known .The average yield of tubers is about 3000 to 4000 kg per acre. In some parts of Indonesia and Philippines yields as high as 95 tons per hectare have been reported.

The tubers are delicious and cooling in effect and are eaten raw. They can also be sliced and made into chips. They are highly nutritious and contain protein 1.47, fat 0.09, starch 9.72, reducing sugars 2.17, non-reducing sugars 3.03, copper 0.43, iron 1.03 and calcium 16.0 mg/100 g. Vitamins viz., thiamin, riboflavin, niacin and ascorbic acid are present in varying proportions. The tubers are also used as fodders. Mature tubers also yield a starch of superior quality.

SCIRPUS KYSOOR

The plant produces small, edible tubers of irregular shape one to three cm in diameter. These are sweetish and very tasteful. It is found under wild conditions more or less throughout India and is sometimes cultivated in some areas in Upper Gangetic Plains. In taste they are comparable to that of the tubers of *Eleocharis dulcis*.

XANTHOSOMA MAXIMILANI

This is a Malayan aroid which has been recently introduced into India. The plant grows under semi-aquatic situations and produces rootstocks 20 to 40 cm long and 6 to 10 cm in diameter. The corms are not fibrous and when boiled become very soft and non-mucilaginous and are tastier than other tuberous aroids.

This plant is cultivated only on a very small scale in certain parts of Bengal and Bihar.