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Tapioca

By

SRI V. T. SUBBIAH MUDALIAR,
Lecturer in Agriculture, Coimbatore.

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Tapioca is grown in large areas in Malabar and Travancore along the West Coast, taking advantage of the heavy rains from June to December. It is serving as a subsidiary food crop for the poorer classes of people, particularly in lean years. It is also an efficient substitute for rice to some extent, supplying the necessary carbohydrates. The accompanying statement furnishes the food values of rice and tapioca, based on the average yields obtained in the Madras State and the food values given in published literature.

		Rice	Tapioca
1.	Duration in months	5	7—10
2.	Acreage in Madras State	10,774,620	42,600
3.	Yield in pounds per acre	1,127 (clean rice)	9,432 (tubers)
4.	Protein in pounds per acre	78	68
5.	Carbohydrates in lb. per acre	892	3,651
6.	Calories per acre (in thousands)	1,776	6,794

Tapioca produces nearly four times as many calories as rice, from the same area. Such comparisous have however their limitations, as there are wide variations in the requirements in soil, climate and water of different crops and fundamental differences in the duration of the crops. Any comparison made has therefore to be treated only as indications.

The following analysis gives the food and vitamin values of tapioca tubers, both raw and dried, and rice as percentages :—

	Tapioca tubers		Rice
	Raw	Dried	
Moisture	59·4	13 0	13·0
Protein	0·7	1·5	6·9
Fat	0·2	0·4	0·4
Mineral matter	1·0	2 1	0·5
Carbohydrates	38·7	82·9	79·2
Calcium	0 05	0·11	0·01
Phosphorus	0·04	0·09	0·15
Iron	0·9	1·9	1·0
Vitamin value per 100 grams			
Vitamin A	...	...	...
Vitamin B	15	32	20
Vitamin C	...	...	...
Calorific value per 100 grammes	159	341	348

The air-dry tuber material is as rich as rice in carbohydrates and the value of the other nutrients is not much less. The tubers are mainly a carbohdrate food, capable of making up the deficiency of rice as a subsidiary food.

There is at present a shortage of food produced in the country, which is made up by imports of grains from other countries at great cost. This is not desirable, nor can it be a lasting and permanent solution. The production has to be linked up with the requirements and consumption in the country. Imports of food grains should be stopped and India should produce its own food. Everything that will help in reaching the target has its place in our development programmes. The production of subsidiary food crops like tapioca to replace cereals in part is one of the main lines of attack suggested. Tapioca produces about one and two-thirds of a ton of carbohydrates per acre, while rice produces only two-fifths of a ton. The production of carbohydrates through tuber crops like tapioca should assist materially in tiding over the food shortgage. This then would appear to be the proper thing to do and it has been shown to be feasible in Travancore and Malabar by the poorer classes of people. It is imperative that the people should learn to adjust their food habits to the prevailing conditions, so that there may be less of privation and suffering on the whole.

The Tapioca Plant: The tapioca plant is also known as the 'cassava' in other countries. Its botanical name is '*Manihot utilissima*'. It belongs to the family of Euphorbiaceae and other known members of the family are the castor plant and the rubber tree. Tapioca is an erect shrub, not much branched, that grows to a height of 6—9 feet. Some of the roots get thickened in due course by storage of starch. The plant is capable of being propagated both vegetatively, as well as sexually. It is usually propagated vegetatively only. It is treated as an annual crop, though it has perennial habits. The tubers have small amounts of cyanogenetic glucoside, which hydrolyses and sets free hydrocyanic (prussic) acid, a virulent poison. The glucoside present in cultivated forms is generally negligible. There are allied wild types having a bitter taste and larger quantities of glucoside. The glucoside is destroyed by cooking and the tubers are thereby rendered safe for consumption. The duration of the crop ranges from 7 to 12 months. There are minor differences in the leaf, stem and tuber characters of the varieties under cultivation.

Climate, Water and Soil Requirements: The crop is grown in tropical and sub-tropical regions and at elevations upto 2,500 feet, but the crop is at its best only at lower altitudes. It is said that it is grown in America at elevations upto 7,000 feet above sea-level. Tapioca stands drought well, but not stagnation of water. Tapioca planted in Malabar in

December with the last rains, establishes itself and makes a little growth before summer. The young plants are able to withstand the summer conditions and recommence growth in May, on receipt of rains. The crop thrives in open sunny situations and does not grow properly in the shade.

The crop is grown under a wide range of rainfall. It is grown in regions receiving less than 20 inches of rainfall in America under sub-tropical conditions. It flourishes in tropical Malabar with a rainfall of about 125 inches during the growing period, and thrives in Visakhapatnam district, where the rainfall is about 30 inches during the crop season. It does well under irrigation but does not tolerate saline water.

It is grown also in a variety of soils. The sandy soils of the East Coast, the laterite soils of the West Coast and the red loams of the central districts grow good crops of tapioca. Even the hill slopes and waste lands considered unsuitable for other crops grow good crops of tapioca in Malabar and Travancore, while in the richer red loams by their side, the crop is more exacting in its water requirements.

Clayey and sticky soils do not permit the full development of the tubers. There is difficulty in digging the tubers and the cost of cultivation is unduly increased. Saline soils are not tolerated by the crop.

Tapioca is an exhausting crop and responds well to liberal manuring combined with heavy irrigation. Because of this, the crop that follows tapioca is generally poor, unless it is manured adequately.

Season: The general planting season is June-July, with the break of the South-West monsoon, whether the crop is grown under irrigated or rain-fed conditions. June-July planting gives the benefit of both the South-West and North-East monsoons and makes it possible to cultivate this long duration crop sucessfully. Where the South-West monsoon is not effective, the planting is done in September and October, with the commencement of the North-East monsoon, as in the southern districts and as a second crop in the Nilgiris. Where pre-monsoon showers are received as in Nilgiris and Tanjore, the crop is planted even in April and May. It is also planted in December and January in the garden lands of Visakhapatnam, Chingleput and South Arcot districts, where there are facilities for irrigation.

In North India, tapioca is planted in March, after the cold weather. In Uttar Pradesh (U. P.) the crop is planted in February to April, with the April planting giving the best results. It is planted right through the year in Travancore, excepting during the dry months, December to March. Thus the crop is not season-bound.

Varieties: A large number of varieties are grown all over the world. There are varieties that mature in 6 months and there are others that take 10—21 months to develop the tubers. There are differences between the varieties in morphological characters such as the height of the plants, shape of the leaves, colour of the stems, leaves, petioles and tubers, and so forth. The colour of the rind of the tubers range from white to chocolate brown, through shades of yellow and white. The colour of the flesh of the tubers is either white or cream. The tubers are spindle-shaped and vary in thickness and length. The cyanogenetic glucoside of the tuber also varies. The cultivated varieties have only a trace of the glucocide and are sweet. The wild forms have a higher glucoside content and the raw tubers are bitter to the taste.

Preparatory Cultivation: The land is prepared by ploughing with the common wooden plough 3 to 5 times to bring about a good tilth. Manure is applied before the last ploughing. The land is finally ridged up, with the ridges 3 to 4 feet apart, or laid into beds 3 to 4 yards square in irrigated lands. In dry lands, the land is either ridged up or pits are dug 3–4 feet apart either way for planting. The pits are usually 1 ft.×1 ft.×1 ft. The land is dug up in the Nilgiris and the hill slopes of Malabar. Later ridges are made 3–4 feet apart, with contour drains every 15—20 feet to take off the surplus water during heavy rains.

Manuring: Cattle manure is commonly applied at 10–20 cart loads (=5—10 tons) per acre, before the last ploughing almost throughout the state. Sheep-penning is also done in Visakhapatnam district, at 1.000 sheep per acre. In Malabar, where cattle manure is in short supply, 4–5 cartloads of cattle manure, 2–3 cartloads of green leaves and 10 gunny bags of wood ash per acre are applied. In Godavari, ammonium sulphate is used for top dressing the crop at 100 lb. per acre, two months after planting, in addition to the cattle manure applied during the time of preparation of the land. In Travancore, the pits dug for planting are filled with dry leaves and burnt to ward off white-ant attack. It is said that the application of wood ash helps in the formation of good-sized tubers. West Coast soils are deficient in potash and ash supplies potash so necessary for the elaboration of starch in the green leaves and its translocation to the tubers.

Planting: Tapioca is propagated by planting stem cuttings called 'setts'. The stems of the previous crop are cut, bundled and stored in shade, for use later as planting material. The stems could be kept over for 2—3 months. The stems are cut into bits at the time of planting. The top portion upto a third of the total length that is

tender and not suitable for planting is rejected. A small length at the basal end that is dry is also rejected. The setts are 6—9 inches in length and each stem gives 6-8 setts. Cuttings upto 18—24 inches are used in other countries. Trial indicate that cuttings from the basal end give rise to the largest yield and cuttings from the apical end the lowest yield.

The setts are usually planted in a slanting position, burying inside the soil 4-5 inches of the cuttings leaving 3-4 nodes above the ground. Setts are planted vertically in certain countries and horizontally in places like Malaya. The number of cuttings required for planting depends upon the spacing given. With 3 feet of spacing either way, 5,690 setts plant an acre and with $2\frac{1}{2}$ feet spacing both ways, 7,200 cuttings are required. Of the setts planted, 70—90 per cent strike root and spare sets are reserved for filling up gaps later.

Irrigation: The crop is grown as a dry crop, mostly in Malabar, Nilgiris, South Kanara and Visakhapatnam districts. Planting is done, with the commencement of the rains and pot watering is done, if necessary, till the sets establish themselves. In other places, tapioca is an irrigated crop. An irrigation in given on the day of planting, followed by two light irrigations at intervals of 3-5 days and the setts establish in 7-10 days. No other irrigation is normally necessary till the close of the monsoon season. Thereafter irrigations are given at intervals of 10—15 days and 15—20 irrigations are required in all, depending upon the soil and the rainfall. The lighter types of soils require a greater number of irrigations than the heavier types.

After-Cultivation: Hoeing, removing weeds and earthing up the plants are the after-cultivation operations done to the crop. The number of times the several operations are done vary from place to place, depending upon the rainfall and weediness of the crop. Hoeing and weeding are done 4—6 times at intervals of about a month and earthing up twice normally, once when the crop is 4 months old and second two months afterwards. The plants are topped sometimes and their growth is limited to 6 feet for facilitating the development of tubers, but this is not a general practice.

Pests and Diseases: Tapioca is a crop that is fortunately free of pests and diseases in this country.

Harvesting: The crop is harvested after the tubers are fully developed. The maturity of the crop is indicated by the yellowing, drying-up and shedding of the leaves. The soil at the base of the plant develops cracks at this period, due to the enlargement of the tubers underground. A few plants are dug and the tubers are examined for their development and maturity. The soil does not stick to the

mature tubers and the tubers do not snap easily after maturity. Flowering and fruiting of the plant are sometimes seen, but these do not indicate maturity of the crop,

An irrigation is given before harvest to moisten the soil and facilitate the harvest. The plants are pulled out with the tubers in light soils. In loamy soils, it is necessary to dig out the tubers with crow-bars and *mammoties*. The stems are cut, bundled and stored in shade covered with leaves for use as setts later. The stems keep in good condition for planting upto 2—3 months, depending upon the weather conditions.

Yields: The yield varies with the soil, its fertility, rainfall and intensity of cultivation. An average of 12 thousand pounds of tubers are obtained from an acre in garden lands, 5—6 thousand pounds from the East Coast drylands and 8 to 10 thousand pounds from the West Coast drylands. High yields of 15—20,000 lb. are often obtained from fertile garden lands and 15—18,000 lb. from the drylands of Malabar. Large yields upto 33,000 lb. are said to be obtained in Malaya. The average yield in U. S. A. is 11 to 13 thousand pounds, though yields upto 35,000 lb. are sometimes secured under intensive cultivation. The longer the duration of the crop, the higher is the yield of tubers, as a rule.

The tubers do not stand storage. They are fit for cooking for a week, from the time of digging, until the tubers get darkened and bluish about the central core, due to the concentration of the cyanogenetic glucoside. In view of their short storage life, the tubers are lifted from the soil only as and when required. The crop can, be kept on the land for about 3 months after maturity. but the tubers get fibrous, coarse and unfit for cooking, in course of time. The tubers are 2—3 inches in diameter and 9—18 inches in length, weighing 2—5 lb. each. If the crop is left on the land for two seasons, coarse giant roots are developed, weighing upto 24 lb. in extreme cases.

Tapioca leaves are often used for feeding goats. Of the stems. 10 per cent is reserved for planting and the rest is dried and used as fuel.

Marketing: The fresh tubers are sold in shandies and market places for use as vegetables. The tubers are boiled with salt and sold in bazars and thoroughfares and are purchased by the poorer classes of people and labourers to serve as a light repast and occasionally as a meal. It is not a complete food by itself and needs the inclusion of legumes to make it more balanced. In Malabar and Travancore, tapioca and fish are a stand-by for the poorer classes, in years of scarcity and famine.

Tapioca Preparations: Tapica tubers contain variable quantities of a cyanogenetic glucoside, which produces prussic acid on hydrolysis. The tapiocas under cultivation have only traces of the glucoside, but still it is not considered desirable to use raw tubers for consumption. The tubers have to be processed for destroying the glucoside, and it is advisable to supplement tapioca with small quantities of proteinaceous foods like fish, eggs, milk, meat, pulses etc. The following methods of preparing the tubers effectively destroy the glucoside present.

(1) The tubers are peeled, sliced and boiled with an excess of of water in open vessels till cooked. The water is drained and the cooked tubers, are made into curries of different types or consumed as such.

(2) Tubers are peeled, sliced and throughly dried in the hot sun. The dried chips are free of glucoside and could be kept in storage or made into flour and stored. The flour is used for making cakes, biscuits, *puttu*, etc. Roasted pulse flour is sometimes added to improve the flavour, taste and nutritive properties. The chips can be ground and made into porridge, which is easily digested.

(3) Thin slices of tubers are fried in oil, seasoned with salt and pepper or chilli powder and eaten as snacks.

Manufactured Products: Starch, sago, semolina and flour are made out of tapioca tubers on a commercial scale in Salem and Coimbatore districts-

Tapioca starch: The rind or skin of the tuber is peeled with stainless steel knives or pieces of bones shaped and sharpened in a suitable manner, as the resulting starch is stained if iron knives are used for peeling. The peeled tubers are rasped by power-driven machinery and reduced to a pulpy mass. The pulp is transferred to cement tubs containing water and stirred well, and the turbid liquid is passed on to another tank, where the suspended starch is allowed to settle down and the supernatant liquid is drained. The starch paste obtained is called 'crude starch' which is again agitated with a fresh charge of water and resettled in a third tank for obtaining purified starch. The supernatant liquid is drawn off and the starch is transferred to a muslin cloth to facilitate water being drained. Centrifugal machines are also used for separating water. The starch is finally spread out for drying. The dry starch is then packed for sale. A weak solution of caustic soda is added to all the vats used in the manufacture of starch, to keep the liquid slightly alkaline, in order to prevent fermentative changes taking place.

Starch can be made in a similar way in the ordinary household also. Peel the skin, grate the tubers into pulp and place it in a muslin bag. Knead the pulp in a vessel of water, when starch passes through the bag into water like streaks of milk and the fibrous matter is left behind in the

bag. The kneading may have to be continued in 2 or 3 changes of water to extract the entire starch in the pulp, till the water escaping from the bag is clear and free of starch. The starch is allowed to settle down and the supernatant liquid is drained. The wet starch is spread over a clean cloth and drained in the sun.

(2). *Sago:* The wet starchy paste is dried and rubbed over wire sieves of suitable size even when there is a little moisture, to produce granules of the same size. The granules are then rocked to and fro on pieces of cloth held stretched by coolies. The granules get rounded and form small rounded pellets. The pellets are lightly toasted and graded. The small pellets are sold as 'Sago' and the big pellets are sold as 'Pearl tapioca' or 'Pearl sago'.

(3) *Flour:* The tapioca tubers are peeled, sliced and dried in the sun. The dry chips are made into flour by passing trough a disintegrator and mill. The flour is made up of the starch and the crude fibre present in the original tubers and is therefore coarser to the feel than tapioca starch.

(4) *Semolina:* Tapioca tubers are sliced, boiled and dried. The dry slices are ground coarse in flour mills, and graded by suitable-sized sieves for separation into various fractions. The coarse fractions have the appearance of semolina made of wheat and the hotels are nowadays using this tapioca semolina for preparing *Uppuma*.

The output of starch and sago varies from 12—18 per cent of the weight of the fresh tubers, depending upon the maturity of the tubers and the efficiency of manufacture. The flour output is 25 per cent of the weight of the tubers.

The flour is used in the household for making porridge, and cakes of various types fried in oil. It is used by the trade for adulterating the costlier wheat and other flours sold to bakeries and coffee hotels for the manufacture of biscuits, cakes, sweets and savouries.

Attempts are being made to convert the tapioca flour into materials which will cook like cereal grains like rice without becoming a pasty mass. It is said that a mixture of 70% of tapioca flour, 20% of groundnut cake flour and 10% of wheat flour lends itself for being made into a vermicelli-like substance and which could be added to rice upto 20% easily, while cooking. Suitable methods of processing tapioca, either by itself or with other materials, into forms that will appeal to the tastes of the people require to be evolved. The stomach has through long years of habit accustomed itself to digest certain forms of food better than others. This aspect has to be given due consideration, while evolving new types of food.

Sago gruel is an invalid food and is easily digested. Other forms of tapioca are also easily digested. South Indian coffee hotels and bakeries are using tapioca flour freely for various preparations. The trade is said to mix tapioca flour with other costlier flours successfully. Tapioca flour and products have to be used to a larger extent as a subsidiary food to tide over the present shortage of food grains. It is suggested that tapioca flour may be used for replacing rice flour, either partially or entirely, in preparations like *dosais*, *iddalies* and cakes of various types.

Cost of cultivation and returns: The cost of cultivation of tapioca is liable to vary widely but a rough estimate of the cost of cultivation in an acre of land is, however, given below, assuming that all items of labour, seed and manure are paid for.

Cost of cultivation of tapioca per acre

Particulars	*Cattle* pairs @ Rs. 2-4-0 a day	*Men* at Re. 1 a day	*Women* @ 8 as a day	*Cost* Rs. A. P.
Ploughing 4 times.	8	8		26—0—0
Forming ridges and rectifying		6		6—0—0
Carting and applying manure	1½	2¼	3	7—8—0
Cost of 10 cartloads of cattle manure at Rs. 4/- each load				40—0—0
Planting setts		1	6	4—0—0
Cost of 7,500 setts at Rs. 2/- per 1,000 setts				15—0—0
20 lift irrigations with mhote	50	50		162—8—0
Guiding water		20		20—0—0
Weeding twice			16	8—0—0
Earthing-up twice		10		10—0—0
Harvesting and carting tubers	2	8	12	18—0—0
Lease of land				60—0—0
Total expenditure	61½	105¼	37	377—8—0

Receipts

Value of 15,000 lb. of tubers at 20 lbs. per rupee	600—0—0
Value of stems (lump sum)	10—0—0
Total receipts	610—0—0
Net profit per acre	232—8—0

If an electrical motor and pump were used for lifting water, instead of mhote and bullocks, the cost of 360 units of electrical energy for 20 irrigation would be Rs. 22—8—0, instead of Rs. 162—8—0 with mhotes and there would be saving of Rs. 140/- and the net profit would be increased by Rs. 140/- and be Rs. 372—8—0 per acre.

Among the items of cultivation listed, the quantity of manure applied and the number of irrigations given are liable to vary widely and these variations influence the cost of cultivation and the yield obtained in a marked manner. The cultivator has the setts required for planting, the manure and the bullocks for lifting water from wells. In addition, the cultivator and members of his family work in the field and save labour to an extent. The amount actually spent on cultivation is therefore much less than what has been figured above. The efficient *ryot* reduces the expenditure on cultivation to the utmost without at the same time allowing the efficiency of production and the yields to be affected.

The profit obtained is the difference between the cost of cultivation and the price secured for the produce, which depends on the volume of the produce and the price at which it is sold. The yield and the selling price of produce are liable to fluctuate widely and such fluctuations tell on the final net profit obtained. Further, the produce obtained has been assumed to be 15,000 lb. of tubers per acre. This is a low yield for the high manuring and the heavy irrigations given and the yield obtained under such intensive cultivation would normally be much higher. Taking all these into consideration, it may be stated that the cultivation of tapioca is a profitable business that should appeal to the cultivator, Tapioca is an important commercial food-crop and cultivating tapioca at this time of shortage of food supply is a service to the country and profit to oneself.