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Production Preference and Importance of Passion Fruit (*Passiflora Edulis*): A Review

Rocky Thokchom[1] and Goutam Mandal[2]

[1,2]Department of Horticulture & Postharvest Technology, Institute of Agriculture, Visva-Bharati, Sriniketan- 731236, WB.
E-mail: [1]rockythokchom@rocketmail.com, [2]gmciphet@gmail.com

Abstract—*Passion fruit (Passiflora edulis) a native of tropical America (Brazil) belongs to the family Passifloraceae, is an attractive high value crop. In India, it is found to be grown wild in many parts of Western Ghat such as Nilgiris, Kodaikanal, Shevroys, Coorg and Malabar and North Eastern States like Manipur, Nagaland and Mizoram. Fruits are nearly round to oval in shape with tough rind which is smooth and waxy and weighing about 35 to 40g in yellow species (P. edulis f. flavicarpa Deg) and about 60g in purple species (P. edulis Sims) and bears on woody perennial vines. An aromatic mass of double-walled, membranous sacs containing orange colour pulpy juice and as many as 250 small, dark brown to black pitted seeds, inside the fruit are the edible portion. The fruit has high nutritional and medicinal value. It is a rich source of Vitamin A and C and contains fair amounts of iron, potassium, sodium, magnesium, sulphur and chlorides and has dietary fibre and protein. Fruits are eaten fresh or processed into products like jams, squash, juice, cakes, pies and ice-cream. Recently, in India, passion fruit cultivation is confined in an area of 19.01 thousand ha with a production of 123.94 thousand tons. Therefore, it is necessary to realize the full potential of this fruit with much more research into the growing and management in order to increase its cultivated area and production. This review paper outlines the nutritional, medicinal, economic importance, future prospects, cultivation and post-harvest management of passion fruit.*

Keywords*: Passiflora edulis, nutritional, medicinal, production, cultivation and management.*

1. INTRODUCTION

Fruits are widely accepted as important component of a healthy diet and adequate consumption could help to reduce a wide range of diseases [3]. Promoting increased production (for availability, affordability, and access) and consumption for maximum health benefits is a global concern. Passion fruit (*Passiflora edulis*) is an attractive, nutritious fruit crop highly appreciated for fresh consumption and industrial purposes because of its diverse uses for juice, jelly and ice cream products [8]. It is a perennial woody fruit vine belongs to family Passifloraceae, native to tropical America (Brazil) [7], bears hermaphrodite, solitary flowers located in the leaf axils. The fruit is round or ovoid and has a tough, smooth, waxy dark purple or yellow hued rind with faint, fine white specks. Inside, the fruit is more or less filled with an aromatic mass of double-walled, membranous sacs containing orange colour pulpy juice and as many as 250 small, hard, dark brown to black pitted seeds. A ripe fruit is refreshing, delicate flavour with pleasing aroma and high nutritive value. In India, passion fruit can successfully be grown well up to 2000 m altitude with an annual rainfall of 1000 to 2500 mm. India has enjoyed a moderate harvest of purple passion fruit in the Nilgiris, Wynad, Kodaikanal, Shevroys, Coorg and Malabar in the south and in various parts of northern India, especially Himachal and North East states like Manipur, Nagaland Mizoram and Meghalaya. In many areas, the vine has run wild. The yellow form was unknown in India until just a few decades ago when it was introduced from Sri Lanka and proved well adapted to low elevations around Chennai and Kerala.

2. TYPES

There are two recognized forms of edible passion fruit; purple (*Passiflora.edulis* Sims) and yellow (*Passiflora* f. *flavicarpa* Deg.). The purple passion fruit is originally native of Tropical America, whereas yellow passion fruit is being considered as a mutation of the purple variety or as a natural hybrid between purple and another related species of passion fruit [1]. *Passiflora quadrangularis* L., the giant granadilla, is also cultivated to a limited extent for local consumption. It grows best in a hot, moist climate and produces a round or oblong, pale yellow to yellowish-green fruit when ripe, which may reach up to 8 inches in size. *Passiflora foetida* L., a wild species, bears very small fruits and has unique characters of being highly precocious and very short fruit maturity period [4]. Purple and yellow are commonly cultivated in northeast region of India, while Kavery (hybrid between purple and yellow) is common in south India [6].

Purple Passion Fruit

Vines are productive at higher elevations. Fruits are 4-5 cm in diameter, deep purple when ripe each weighing 35-45 g. The juice content varies from 31-35 per cent. The variety is known

for its quality in terms of flavour and nutrient content. Seeds are black in colour. The variety is susceptible to leaf spot, collar rot, attack by thrips and nematodes.

Yellow Passion Fruit

This variety is suitable for lower elevations and is less productive at higher elevations due to its sensitiveness to low temperature. The fruit is bigger in size than purple variety, each weighing about 60 g, round in shape with yellow mottled spots, turns golden yellow when ripe. Juice is more acidic, its recovery being comparatively less than the purple. Seeds are brown, tolerant to leaf spot and wilt, escapes the damage by thrips and tolerant to nematodes.

Giant Granadilla

The giant Granadilla has large leaves, and bears very striking flower. The greenish-yellow fruits of *P. quadrangularis* resemble melons and are the largest in the genus. Fruits are 15-20 cm long and about 600g weight. The fruits are oblong, with a delicate aroma and a thin, smooth skin. Fruit contents thick pulp with large seeds.

Kaveri Hybrid Passion Fruit

It is a hybrid between Purple and Yellow passion fruit developed at Central Horticulture Experimental Station, Indian Institute of Horticulture Research, Chettalli, Karnataka. It is a high yielding variety and each fruit weighs 85-110 g. The fruits are purple in colour, fruit quality comparable to that of Purple variety. The variety is reported to have field tolerance to brown leaf spot, collar rot, wilt and nematodes.

3. IMPORTANCE OF PASSION FRUIT

According to, Joy [5], the fruit has high nutritive and medicinal value. Passion fruit is a high acid food (pH~ 3.2) due to the predominance of two acids, citric and malic acid. The fruit provides a good source of nutrients such as Vitamin A, B2 and C and non-nutritive phytochemicals, carotenoids and polyphenols. It is also rich in minerals like K, P, Ca, Fe, Na, Mg, S, Cl and protein (Table 1.). Passion fruit is also known as a nutritionally dense fruit, based on the level of nutrients present. The high amount of vitamin A, C and B2 in passion fruit is the primary driver of such nutritional scores. Nutritional composition of passion fruit per 100g is enumerate in Table 1. Passion fruit can be grown to eat or for its juice, which is often added to other fruit juices to enhance aroma. The fruit is eaten alone or in fruit salads, sherbets, ice cream, jams, cool drinks and as concentrates. The yellow variety is used for juice processing, while the Purple variety is sold in fresh fruit markets. It has been reviewed by Zas and John, [12] that *Passiflora edulis* plant contains anti-inflammatory, anticonvulsant, antimicrobial, anticancer, anti-diabetic, antihypertensive, anti-sedative, antioxidant properties and various remedial measures for treating conditions like osteoarthritis, asthma and act as colon cleanser. The different parts of the plants have also been used for treatment of ulcers, haemorrhoids, as sedatives, remedy for insomnia, digestive stimulant and remedy for gastri carcinoma. Various, physico-chemical composition of various species of ripe passion fruits has been enumerate in Table 2.

Table 1: Nutritional composition of passion fruit per 100g.

Nutrients	Nutritional value per 100g	Nutrients	Nutritional value per 100g
Energy	97 kcal	**Thiamine**	0.0 mg
Carbohydrate	23.38 g	**Vitamin A**	1274 IU
Protein	2.20 g	**Vitamin C**	30 mg
Total fat	0.7 g	**Potassium**	348 mg
Cholesterol	0.0 g	**Calcium**	12 mg
Dietary fibre	10.4 g	**Iron**	1.60 mg
Folates	14 µg	**Magnesium**	29 mg
Niacin	1.5 mg	**Phosphorus**	68 mg
Pyridoxine	0.1 mg	**Carotene**	743 µg
Riboflavin g	0.130 mg	**Crypto-xanthene**	41 µ

(**Source:** *USDA National Nutrient Data Base*) [10]

Table 2: Physico-chemical composition of various species of ripe passion fruits

Characteristics	*P.edulis*	*P. edulis f. flavicarpa*	*P. quadrangularis*
Fruit weight (g)	45-60	80-115	120-480
Fruit length (cm)	3.5-6	8-10	20-30
Fruit diameter (cm)	3.5-7	5-7.5	10-12
Pulp weight (g/100g)	32-44	26-31	22-48
Rind weight (g/100g)	51-65	57-68	42-65
Juice recovery (%)	30-34	24-26	22-26
TSS (°Brix)	14-18.4	12.4-16.4	16-18
Titrable acidity (%)	2.4-3.0	3.4-3.8	2.4-3. 2
TSS/Acid ratio	5.8-6.1	3.64-4.31	5.6-6.6
Total sugar (%)	5.8-8.0	5.4-6.8	4-4.8
Reducing sugar (%)	3.5-4.2	4-5.2	3-3.8
Non-reducing sugar (%)	1.8-2.5	1.2-2.0	2.2-2.8
Ascorbic acid (mg/100g juice)	22-32	16-20.4	14-18
Weight of residues (g/100g)	3-5	6-12	10-15

(**Source**: *Sema and Maiti*) [9]

Table 3: Indian Production of passion fruit (2014-15).

Sl. No.	State	Production ('000 MT)	Share (%)
1	Manipur	99.16	76.71
2	Nagaland	21.25	16.44
3	Kerala	6.75	5.22
4	Mizoram	2.11	1.63
5	Sikkim	0.00	0.00
Total production		129.27	

(**Source:** *NHB*) [2]

4. CURRENT SCENARIO IN INDIA

In India, passion fruit cultivation is confined to north-eastern states (Manipur, Mizoram, Nagaland and Sikkim) and Kerala, Tamil Nadu (Nilgiri hills and Kodai Kenal), Karnataka (Coorg) and with an area of 19.01 thousand ha and production of 123.94 thousand tons [2]. Manipur share highest production of passion fruit in India followed by Nagaland (Table. 3).

Passion fruit industry

Manipur has two processing units (Exotic Juices & one new), while Nagaland has three units (Lungnak -closed down, Fruit &Veg. processing unit -Dimapur -Privatized & new -Mokokchung) and Mizoram has one unit (new) for processing passion fruit. The juice drink "Pasip" manufactured by Exotic Juices Ltd from fruit grown and processed in Manipur, having a capacity of 1.5 million litres is marketed by EcoVerse. Pasip is being marketed in all the major cities of India and will soon be exported. Large scale passion fruit cultivation and setting up of a state of the art processing complex with latest process know-how was made possible with the much-needed support from SFAC, NEDFI, APEDA, MOFPI, SBI and Exim Bank. [5]

5. CULTIVATION

Climate and Soils

The yellow passion fruit and giant granadilla are tropical plants, while purple passion fruit is adapted to subtropical conditions and endures a few degrees of winter frost without injury, but will not tolerate severe freezes. It requires an optimum temperature of 20^{o} to 30^{o} C for vegetative growth and flowering. It can grow well up to 2000 m altitude with an annual rainfall of 1000 to 2500 mm. Vines prefer almost neutral, (pH of 6-7) well-drained soil with high organic matter (2%), but the yellow passion vine may tolerate alkaline soils. Extremes of heat and cold may prove damaging to the vine, high temperatures causing them to grow luxuriantly but with very little fruit setting.

Propagation

Passion fruit is propagated by seeds, cuttings and grafting on resistant root stocks. Seedlings and grafted plants are more vigorous than cuttings.

Seed Propagation

Fruits are collected from superior vines in respect of yield and quality. The pulp after extraction is allowed to ferment for 72 hours and seeds are extracted. The seeds are sown in well prepared seed beds during March-April. The seedlings after attaining 4-6 leaves stage are transplanted in 10 cm x 22 cm polybags filled with a mixture of soil, compost and sand (2:1:1). The seedlings will be ready for transplanting in the main field in about three months.

Vegetative Propagation

Semi-hardwood cuttings of about 30-35 cm length of pencil size with 3-4 nodes are ideal. The cuttings are to be first placed in sand beds/pots for root initiation and then transferred to polybags for better root development. The rooted cuttings are ready for planting in about three months.

Spacing and Planting

The spacing will vary depending upon the type of training system being followed and variety. In case of Kniffin system of training the spacing adopted is 2m x 3m, which will accommodate 1666 plants/ha. In bower system, the recommended spacing is 3m x 3m which accommodates about 1110 plants/ha. According to Usha *et al*., [11], the planting distance for Purple, Yellow and Kaveri passion fruit is 2m x 2m.

Preparation of Land

Pits of 45 cm^3 are dug at a spacing of 3m x 2m, on hill slopes/plains. The pits are filled with a mixture of three parts of top soil and one part of compost and planting is done during May-June after onset of monsoon. Turmeric and ginger could be grown as intercrops.

Training

Vine are trained on two-arm kniffin system trellies run in north-south direction to facilitate proper sunlight. Posts, either bamboo or iron, should be fixed at the distance of 3-4 m and on these posts 3-4 wires should be strung by keeping the distance of 30 cm between wires. Once the vines reach the wire, the tips are pinched to facilitate two leaders and these leaders are directed on either side of the wire, which in turn develops laterals. These laterals are intended to bear fruits as passion fruits bear fruits only on current season's growth. Passion fruit can also be trained on pergola system. In this system vines are spread over a criss-cross network of wire (15-20 cm apart), usually 1.8-2.0m above the ground, supported by bamboo posts or iron posts. The vines are allowed to grow single shoot till it reaches to wire. When vine reaches to wire, its tip is pinched to facilitate side shoots on the wire.

Pruning

After the harvest of the crop, the laterals are cut back to 4-5 buds. Pruning should be done after harvesting of the crop in April and December.

Nutrient management

The nutrient requirement depends up on the age and stage of growth viz. vegetative growth, plant coming in bearing and full production stage. The approximate nutrient requirement of passion fruit is N 150, P 100 and K 200kg/ha. The nutrient should be applied in splits after fruit harvest.

Pollination

Passion fruits are protrandrous and adapted to cross-pollination by honeybees. In purple passion fruit and giant granadilla anthesis takes place in the early morning while in yellow anthesis takes place in afternoon. Pollination takes place after 1-2 hours of anthesis when stigma becomes receptive.

Fruit maturity

Purple passion fruit and giant granadilla flower throughout the year but major bloom occur in March-April and July-August. The yellow passion fruit and Kavery major flowering occurs during May – June and during September-October. Fruits of passion fruits mature between 70-80 days of flowering.

Harvesting and yield

The economic yield starts after 1-2 year of planting and a healthy plant produces about 150-180 fruits/year. Purple passion fruit produces more fruits than yellow and giant granadilla due to compatibility of pollens. Approximately 4-6 kg of fruit per plant is likely to be the good production. In a properly managed orchard the average productivity may be 5-6 t/ha. Both purple and yellow passion fruits begin to lose moisture as soon as they ripen and fell and quickly become wrinkled. The fruits can be stored in polyethylene bags at 7-9°C for as long as 3 weeks without loss. Since passion fruit is a climacteric fruit and ripening may also take place off the tree, therefore, fully matured fruits (10-11 weeks old) may be harvested and may be kept for ripening.

Disease and pest

The major diseases in passion fruits are collar/root rot, brown spot and woodiness virus. The incidence of diseases varies with the species. Collar rot is the most common disease of purple passion fruit which can be minimised by using yellow passion fruit as a root stock. The incidence of fruit fly and mite are common in passion fruit.

Constraints

Passion fruit production is constrained by lack of suitable varieties, technical knowhow on crop cultivation, pests and diseases and relatively higher capital investments. Passion fruit having a unique and excellent flavour and aroma has not reached to the majority of the people even within the country due to poor or lack of publicity. Most of the people have not come across this fruit and its processed product which otherwise would have definitely captured their attention and boost the industry in the country. As in many of the Horticultural crops, passion fruit marketing both for fresh as well as processed or semi-processed products is also very weak and almost negligible. Growers are apprehensive to expand the area under its cultivation without assured market for their produce which in turn will result in inadequate volume of raw materials for the processing industries. The productivity and production is very low mainly due to lack of improved varieties. The crop is also susceptible to various diseases and pests. Moreover, post-harvest management aspect of passion fruit is also not given due attention, thus resulting in loss of large quantity of the harvested produce, glut in market and deterioration in quality of the produce.

6. CONCLUSION

Keeping in view the above aspects, it can be concluded that cultivation and production of passion fruit is a technically feasible and can be boost up in the country. The first and foremost step to be taken up is to create an awareness among the people and give wide publicity though different means, then creation of integrated efforts among all the possible stakeholders e.g. farmers, government agencies, research institutions and other agencies and then development of proper market linkages between the investors / business houses and the producers. Strategies like proper post-harvest management, creation of proper storage facilities, development of improve packaging for transportation, improve transport facilities, setting up of new processing unit and strengthening of existing processing unit would certainly boost the passion fruit production in the country.

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