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## Importance and value added products of *Passiflora edulis*

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### Abstract

Passion fruit (*Passiflora edulis*) is a healthy tropical fruit from the Passifloraceae family. The purple passion fruit can be found from southern Brazil to northern Argentina, passing via Paraguay. For a long time, the Nilgiris in the south and several portions of northern India have benefited from a moderate harvest of purple passion fruit. The passion fruit is high in antioxidants, flavonoids, anti-inflammatory, antibacterial, antifungal, and anti-aging compounds. This fruit is extremely valuable economically since all of its parts (seed, peel, blossom, and pulp) contain medicinal and therapeutic characteristics. Besides this it has many applications in food industry. Many value added products are processed from passion fruit. Jam, jelly, syrup, biscuits, pickles, passion seed oil are some of the processed food products from passion fruit.

**Keywords:** *Passiflora edulis*, taxonomy, nutritional composition, disease management, value added products

### Introduction

The passion fruit is named after one of the numerous species of passionflower, which is how the Latin genus name, *Passiflora*, came to be. Several species have been used as traditional herbal treatments for centuries. The name was given to the indigenous people of South America by Spanish missionaries as an explanatory assistance when attempting to convert them to Christianity. The genus *Passiflora* is the largest in the Passifloraceae family, with over 520 species. (Wohlmuth *et al.*, 2010) [29]. This genus' species are found in the mild temperate and tropical zones; they are more uncommon in Asia, Australia, and tropical Africa. The genus *Passiflora* contains a number of native plants known as maracujas in Brazil. The purple form (*P. edulis Sims*) and the yellow form (*P. edulis va r. flavicarpa Degenerer*) of *Passiflora edulis Sims* (Passifloraceae) are both commercially grown. *Passiflora alata* is the official *Passiflora* species in the Brazilian Pharmacopoeia, and *P. edulis* is the most commonly used *Passiflora* species in the culinary industry as a flavouring and juice in Brazil. (Taiwe, G.S. *et al.*, 2017) [27]. Only a few *Passiflora* species have been scientifically examined for their medicinal use. (Akhondzadeh *et al.*, 2001) [1]. The chemical actions of passionflower extracts have been characterised as anxiolytic, spasmolytic, hypnotic, sedative, narcotic, and anodyne. (Ozarko., 2001) [14]. Beta-carboline harmala alkaloids with anti-depressant activities have been discovered in a variety of animals. Only traces of these compounds can be found in the flower and fruit, but the leaves and roots are often more potent and have been used to augment the effects of mind-altering medications. The leaves can also be smoked once they have dried. (AG Ingale and AU Hivrale., 2010).

This plant has a complex phytochemistry and a variety of pharmacological properties. The majority of *P. edulis*' pharmacological studies have focused on its central nervous system (CNS) activities, such as anxiolytic, anticonvulsant, and sedative effects. *P. edulis* extracts have shown promise in preclinical studies for the treatment of inflammation, pain, and sleeplessness, as well as attention deficit hyperactivity disorder, hypertension, and cancer. (Taiwe, G.S. *et al.*, 2017) [27]. *P. edulis* appears to work through a number of pathways, including the suppression of proinflammatory cytokines, enzyme (myeloperoxidase), and mediator (bradykinin, histamine, substance P, nitric oxide) release and/or activity. Antinociceptive, anticancer, antibacterial, and antioxidant activity have been found in the leaves and stems of *P. edulis* (Patel., 2009) [23].

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Traditional medicine based on this plants still holds a significant part in the health-care system. The fruit's pulp is both a stimulant and a tonic. The possible clinical efficacy of *P. edulis* has been studied for a number of ailments, although it is currently most commonly used in clinical practise to treat anxiety and sleep disturbances. *P. edulis* has long been utilised as an ethnic treatment to treat a variety of infectious diseases caused by bacteria, fungi, viruses, mycobacterium, and protozoa. Dried extracts are the most important product derived from *P. edulis*, despite the availability of a number of different preparations. *P. edulis* extracts are used by many practitioners to treat depression and sleeplessness in a wide spectrum of patients, either alone or in combination with other herbal medications. (Zhou *et al.*, 2008) [30]. Jams, jellies, and fruit juices are the most common uses for passion fruit. It can be used as a sedative as well as a food source. Passion fruit is a tasty and healthful addition to the diet since it contains a variety of components such as acids and sugars, minerals, and non-nutritive phytochemicals. It's used to treat depression, anxiety, and stress, as well as insomnia and sleep disorders, headaches, migraines, and general discomfort, as well as stomach issues (colic, anxious stomach, indigestion, etc.) and menstrual cramps and premenstrual syndrome (PMS). (PP Joy., 2010) [21, 22].

It's a perennial woody fruit vine in the Passifloraceae family and has hermaphrodite, solitary flowers in the leaf axils. (Biswas S *et al.*, 2021) [4]. The fruit is spherical or ovoid in shape and has a waxy, dull purple or yellow skin with weak, fine white dots. The fruit is mostly filled with a sweet-smelling mass of doubly walled, membranous sacs with orange shading viscous squeezing and above of 250 small, hard, dim earthy coloured to black pitted seeds on the inside. Under ideal conditions, it can grow up to six metres in a year. The fragrant exotic-looking white and purple flowers that develop on the new growth are protected by the vine's evergreen leaves. A ripe fruit has a revitalising flavour, a pleasant aroma, and a high nutritional value. Passion fruit may be grown effectively in India up to 2000 m altitude with annual rainfall ranging from 1000 to 2500 mm. Fruits are widely recognised as a vital part of a healthy diet, and their consumption can assist to prevent a variety of ailments. (Mishra R *et al.*, 2021) [4]. The fruit is renowned for its distinct flavour and smell, which aids in the production of high-quality squash as well as the flavouring of a variety of other items. Because of its outstanding flavour and nutrition, this healthy fruit crop is highly valued for fresh consumption and industrial applications (BM Santos., 2002) [5]. It is used to make juice, jelly, and ice cream products. Fruits have long been a staple of the human diet. They are high in water, carbohydrate, sugars, vitamins, minerals, and organic components, all of which the body requires to function properly (VO Onibon *et al.*, 2007) [28]. Passion fruit juice is frequently blended with pineapple, mango, ginger, and other liquids to enhance the flavour of the finished product. The juice is often used in confectionary, as well as in the making

of cakes, pies, and ice cream. It's high in Vitamin A and has moderate levels of Sodium, Magnesium, Sulphur, and Chlorides. Yellow passion fruit is commercially processed and generates 36 percent juice, 51 percent rinds, and 11 percent seeds. (PP Joy., 2010) [21, 22].

### Taxonomical classification of *Passiflora*

The passion fruit (*Passiflora edulis Sims.*) is a member of the Passifloraceae family, which includes 12 genera and around 500 species. There are roughly 400 species in the *Passiflora* genus, although only a few are economically significant. There are two distinct forms of these species: the ordinary purple (*P. edulis*) and the yellow (*P. edulis*) (*P. edulis f. flavicarpa Deg.*). The number of chromosomes ranges from 2n=18 to 2n=22. There are 12 species of *Passiflora* listed below. (Biswas S *et al.*, 2021) [4], (PC Tripathi., 2018) [17].

- 1. *Passiflora alata Dryland*:** It is native of Peru and Brazil. It is a woody vine cultivated in Brazil for its fruits.
- 2. *Passiflora antiqueness Karst. (Syn. P. valxsemii (Len.) Traina & Planch.)*:** It is native of Colombia and known as banana passion fruit. This species is also a woody vine cultivated for its fruit.
- 3. *Passiflora cearensis Barb*:** It is native of Brazil and cultivated for its fruits.
- 4. *Passiflora edulis Sims*:** It is real passion fruit which is native of South Brazil. This species is widely distributed throughout the tropics and subtropics. The fruits are especially used for juice preparation.
- 5. *Passiflora foetida L.*:** It is woody species native of West Indies and South America. It is distributed to many tropical countries in Africa and Asia where it has naturalized. The fruits are hardly edible however, in Malaysia and East Africa it is used as cover crop.
- 6. *Passiflora Laurifolia L.*:** It is native of thickets and forest fringes of West Indies and North-East South America. Cultivated for fruits and spread throughout the tropics (Parse glove, 1968).
- 7. *Passiflora ligularis Juss*:** It is native of Tropical America and commonly known as Sweet granadilla. Its sweet fruits are much used in mountainous region of Mexico and central America).
- 8. *Passiflora maliformis L.*:** A vine native to Tropical America and cultivated for fruits.
- 9. *Passiflora mallissima (H.B.K.) Bailey*:** It is native of Andes and commonly known as Banana Passion fruit. It is especially cultivated in Ecuador and Bolivia.
- 10. *Passiflora psilatha (Sondrio) Kilip*:** It is native of Ecuador and known as Gullan. It is a vine grown for fruits.
- 11. *Passiflora quadrangularis L.*:** It is commonly known as Giant granadilla and Barba dine and native of tropical South America. Widely distributed in tropics where it is grown for fruits.
- 12. *Passiflora tripartite (Juss) Poir*:** It is native of Ecuador and cultivated for fruits. It is commonly known as Tasco.

**Table 1:** Nutritional composition (Biswas S *et al.*, 2021) [4]

Nutrients	Nutrient value per 100g	Percentage of RDA
Energy	97 K Cal	5%
Carbohydrate	23.38 g	18%
Protein	2.20 g	4%
Total fat	0.70 g	3%
Cholesterol	0 mg	0%

Dietary fiber	10.40 g	27%
<b>Vitamins</b>		
Folates	14 µg	3%
Niacin	1.500 mg	9%
Pyridoxine	0.100 mg	8%
Riboflavin	0.130 mg	10%
Thiamine	0.00 mg	0%
Vitamin A	1274 IU	43%
Vitamin C	30 mg	50%
Vitamin E	0.02 µg	<1%
Vitamin K	0.7 mg	0.5%
<b>Electrolytes</b>		
Sodium	0 mg	0%
Potassium	348 mg	7%
<b>Minerals</b>		
Calcium	12 mg	1.2%
Copper	0.086 mg	9.5%
Iron	1.60 mg	20%
Magnesium	29 mg	7%
Phosphorus	68 mg	10%
Selenium	0.6 µg	1%
Zinc	0.10 mg	1%
<b>Phyto nutrients</b>		
Carotene-β	743 µg	-
Crypto-Xanthine-β	41 µg	-
Lycopene	0 µg	-

### Disease management

Passion fruit production potential is harmed by a number of diseases around the world. Septoria spot, brown spot, Phytophthora blight, Alternaria spot, woodiness virus, and base rot are the most common diseases.

**Root rot:** Produced by *Phytophthora nicotiana* var. *parasitica*, has been discovered to cause a significant amount of harm. The root begins to rot, and the plant eventually dies. Water is used to control the sickness. By ensuring sufficient drainage, logging can be avoided. Drenching with a Bordeaux mixture (1%) could be beneficial. The injured plants should be mounded with dirt to facilitate the growth of new roots. (PC Tripathi., 2018) <sup>[17]</sup>.

**Brown spot:** The symptoms of the two most prevalent brown spot agents are different. *Alternaria passiflorae* generates 5 mm diameter reddish brown patches on leaves. Spots that grow larger-more than two centimetres in diameter-become circular and zonate when exposed to high humidity. Spores can form a dark thin mass in the centre of the lesion, with abaxial surface. Rapid abscission of damaged leaves can result in severe defoliation. Dark brown lesions on the twigs are more elongated, measuring 2-to 4-cm in length, and can induce girdling and mortality of the terminal region of these species. On mature fruits or when they are halfway through their growth process, little round dots appear. They're reddish brown, sunken, and 1 to 3 cm in diameter, having a negative effect on the fruit's pulp and lowering its commercial value. Disease pressure can be reduced by pruning vines to enhance ventilation and fungicide penetration. Copper compounds, carbamates, and strobilurins are recommended fungicides to be treated at 7-to 14-day intervals from the onset of symptoms, and at longer intervals when conditions are less favourable. (Fischer, I.H., & Rezende, J.A., 2008) <sup>[9]</sup>.

**Phytophthora blight:** This disease causes the vine to blacken and kills new growth, as well as defoliation, withering, and

collapse. Large grey green water saturated spots form on the fruits, causing them to quickly deteriorate. Fruits lose their marketability. (PC Tripathi., 2018) <sup>[17]</sup>. The disease Phytophthora root and crown rot affects both adult and nursery plants. Wilting, defoliation, and mortality are all symptoms of mild chlorosis. The plant's cortical tissues are exposed. (PP Joy and CG Sherin., 2012) <sup>[20]</sup>. The disease manifests itself in certain locations and spreads from one plant to the next. During rainy season, when temperatures range from 26 to 30 degrees Celsius, a high illness incidence is reported in clay soils. Root exudates attract zoospores formed inside sporangia and discharged in the presence of water. The zoospores encyst and germinate when they reach the root surface, creating hyphae that colonise the intra and inter cells of the plant roots, damaging the exterior cortical tissue and avoiding sap circulation. (Ploetz *et al.*, 2003) <sup>[3]</sup>.

**Woodiness virus:** Passion fruit woodiness virus (PWV) and Cucumber woody virus (CWV). PWV and CWV infected plants yield woody, malformed fruits. PWV infection causes severe mosaic, epinasty, defoliation, and premature death of plants. Leaf mottling and ring mark on the younger leaves are also common signs. Fruits have less symptoms or display mild moulting. Chlorotic markings on the foliage are common, as are dappled or fading fruits. (PP Joy and CG Sherin., 2012) <sup>[20]</sup>. Viruses are normally transmitted in a non-persistent, non-circulative manner by several species of aphids. Grafting and experimental mechanical inoculation can also be used to proliferate them. During cultural practises of trimming, mechanical transmission by knives, scissors, and nails is noted. None of the viruses have been found to be spread through seeds. When Passiflora species become infected with this illness, they develop a systemic infection that can be symptomatic or latent. (Parry *et al.* 2004) <sup>[16]</sup>. Because the virus and aphid vectors do not have a long-term association, chemical control of vectors is usually ineffectual. Passion fruit woodiness can be reduced by following specific prescribed cultural practises. Using virus-free seedlings for

new plantings, eradicating old and abandoned orchards before starting new crops, taking care during trimming operations can reduce the disease. (Gloria *et al.*, 2002) <sup>[10]</sup>.

**Septoria blotch (Spot):** *Septoria fructigena*, *S. passifloricola*, and *S. passiflorae* are the three species of *Septoria* that produce spot disease, with *S. passifloricola* being the most widespread. The most damaged organs are the leaves, which have light brown slightly circular necrotic patches that are generally surrounded by a chlorotic halo. Abscission can be caused by a single lesion per leaf, and even leaves with no obvious symptoms may fall early. Partial or total leaf abscission is noticed when the disease affects 15-20 percent of the leaves on the same plant. Lesions in immature twigs can cause girdling, which can lead to wilt and death of the twig tips. (PP Joy and CG Sherin., 2012) <sup>[20]</sup>. In lesions, *S. passiflorae* forms black, round, and subepidermic pycnidia. They have the potential to explode and become ostiolate. The conidia are liberated and agglutinated by a mucilaginous material in the hyaline cirri. Water, dew, and insects distribute the conidia contained in the cirri. Mucilage in the cirrus is suggested to help the fungus survive in infected tissues. (Barry Manicom *et al.* 2003) <sup>[3]</sup>.

#### Value added products from passion fruit

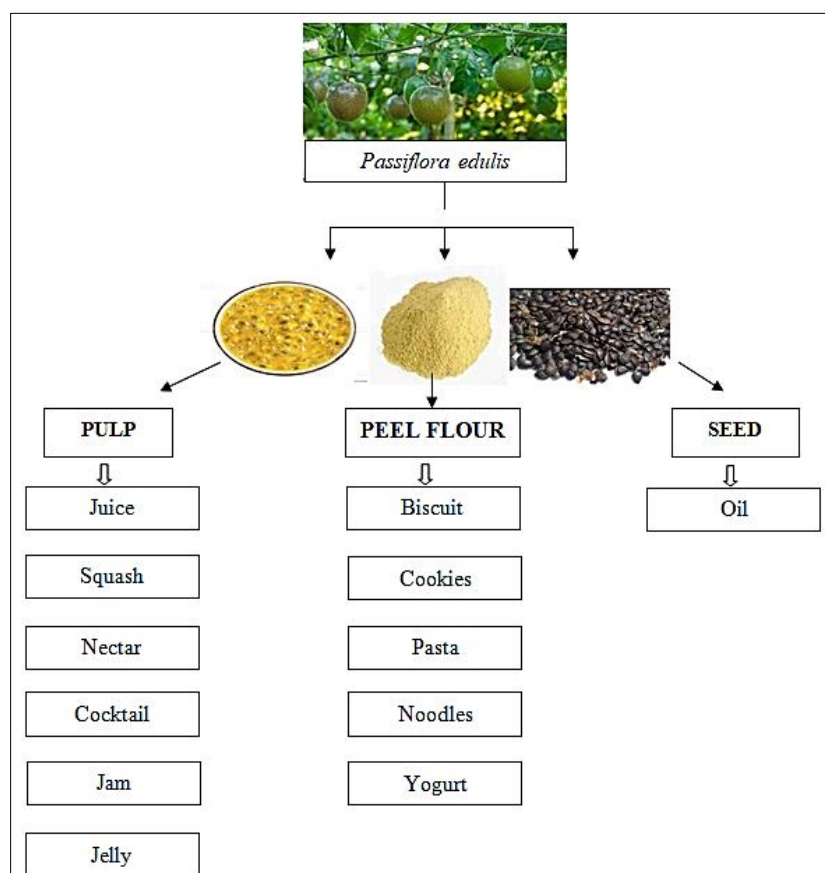
In order to extend the shelf life of perishable fruit, value is added by modifying its form and colour. In the current situation, increasing the amount of value addition and improving the quality of value added fruit products for the domestic and export markets is critical. Passion fruits are generally utilised in food, in the form of juices, jams, jellies, ice creams, and liquors, along with other things. The passion fruit is recognised for its calming properties, but its attractive smell and flavour make it a big industry product. Pass florin, a natural sedative, is found in the leaves and juice, and tea made from the leaves has a diuretic effect. Purgative, sedative, and anti-inflammatory effects are also present. The seeds have antihelminthic properties. Tea leaves are often thought to be an excellent antipyretic and aid in the treatment of skin inflammation, in addition to working as a sedative, however these two functions are based on popular perception. (Biswas S *et al.*, 2021) <sup>[4]</sup>. Because of its distinct aroma, passion fruit was frequently processed into fruit juice, fruit wine, jam, fruit vinegar, and other products. Passion fruit peel, on the other hand, was processed into animal feed or extracted pectin, dietary fibre, and other products. (Zhu XH *et al.*, 2017) <sup>[31]</sup>. Passion fruit juice beverage manufacturing was mostly centred on passion fruit pulp, therefore only the pulp's nutrients were added to the beverage. However, the whole fruit of the passion fruit was processed into a passion fruit juice beverage, resulting in a more nutritious beverage. (Yang YX *et al.*, 2017) <sup>[31]</sup>. Passion fruit pulp or juice is obtained by separating the seed from the pulp. The juice can be preserved for six months to more than a year with the help of additions. During the off-season, the saved juice can be used to make a variety of different beverages for consumption. (Biswas S *et al.*, 2021) <sup>[4]</sup>. The juice obtained from these fruits has a high nutritional content and is extremely beneficial to human health. (Akpan UG & Kovo AS 2005) <sup>[2]</sup>. Passion fruit juice can be collected directly from the fruit or squeezed from crushed material with a significant proportion of pulp (Matta F, 2002) <sup>[12]</sup>. Jam is a semi-solid food created by boiling fruits with sugar (with or without additional pectin and acid) to

increase the total soluble solid content to >65%. (Dubey *et al.*, 2021) <sup>[8]</sup>. Fruit contains the majority of the chemicals in acidity and pectin, which are extracted during cooking. Sugar has a technological function in traditional jam preparation, influencing the soluble content of solids, which is important for the physical, chemical, and sensory aspects of jams, as well as increasing their microbiological stability and safety. The quality of the finished product, on the other hand, is determined by a multitude of elements, including the fruit type and variety, pH, sugar content, pectin type and concentration, and process parameters. (Pandey N *et al.*, 2019) <sup>[15]</sup>. Passion fruit can be processed in to dehydrated products. It is a less challenging process for preparing and extending storage life by physically removing water and drying it with hot air that is cost-effective on a commercial scale. The fresh material is dried to a residual moisture of around 5%, and pre-treatment is applied depending on the needed colouring, flavour, and taste retention. Water can be used to rehydrate the dry material. Dried material has a half-year shelf life when stored at room temperature. Because the bulk weight is reduced, this technique allows for better storage and transportation. Osmodehydrated and intermediate moisture products with a water content of less than 25% can be consumed directly without the need to rehydrate. (Biswas S *et al.*, 2021) <sup>[4]</sup>.

Passion fruit crops are a commercially important species with fats and oils that may be used in the pharmaceutical, cosmetic, and food industries. (Lucarini *et al.*, 2019) <sup>[11]</sup>. The seed oil offers potential for a variety of industrial applications and shares characteristics with edible oils such as soybean oil (Cesar *et al.*, 2016) <sup>[6]</sup>. This product can be used to supplement the supply of bioactive compounds-rich vegetable oils that can be employed in cosmetics and functional foods (De Paula *et al.*, 2015) <sup>[7]</sup>. The oil produced from the passion fruit seed contains volatile chemicals that could be employed as industrial fragrances and could result in high-value natural essences. Furthermore, the oil has the potential to be a source of bio-based chemicals. (Rodrigues *et al.*, 2017) <sup>[24]</sup>. Because of the high acidity and flavour of passion fruit juice, jellies and syrups require a significant amount of sugar and water dilution. Because the juice contains only a trace of pectin, powdered citrus pectin was used to make the jellies. Apple pectin, either liquid or powdered, can also be used. When two parts water and five parts sugar were combined with one part juice and the right amount of pectin, the best tasting jelly was created. (Poore H D., 2015) <sup>[19]</sup>. Individually, fruit and yoghurt have been found as indications of good diet. Passion fruits have a low energy density and are high in antioxidants, prebiotic fibres, and polyphenols, all of which can help with digestive health. The volatile compounds ethyl hexanoate, methyl hexanoate, and D-limonene are mostly found in the pulp of the native Passion fruit, making the product more palatable for eating due to its pungent, powerful aroma. Yoghurt, on the other hand, is a high-nutrient food that contains dairy protein, calcium, magnesium, vitamin B-12, conjugated linoleic acid, and other essential fatty acids. Indeed, the dairy business and academics are currently looking for products that are lower in fat, have little or no sugar, and are fiber-enriched. As a result, the researchers studied to develop a passion fruit pulp and skin powder-enriched yoghurt as an alternative to stirred yoghurt. (Shabong *et al.*, 2021) <sup>[26]</sup>. Fruit pulp can be changed into jam using pectin as a setting agent, whilst juice can be

transformed into jelly under specific sugar and pectin ratios. Marmalade is a jelly-like substance that contains a bitter component, commonly in the form of citrus peel fragments. After seasoning in hot oil of saturated fatty acids to overcome rancidity during prolonged storage, raw fruit peel can be transformed into pickle by mixing in salt and chilli powder, then seasoning in hot oil of saturated fatty acids. Salting and dehydration into "instant pickles" can be packed with chile, salt, and spice powder to minimise the freight expenses of wet pickles and the convenience of handling. The dry pickle can be made into a wet pickle by soaking it in water overnight. Biscuits, cookies, fruit cake, and muffins can all be made from fruit pulp or its dehydrated result. Following juice extraction, fruit pomace can be used with baking flour to improve bakery product functionality by providing a balanced ratio of soluble/insoluble fibre, improved hydration qualities,

and improved sensory properties. (Biswas S *et al.*, 2021) <sup>[4]</sup>. Instead of utilising commercial stabilisers and commercial pectin, pectin from passion peel is used as a stabiliser in the making of ice cream. In comparison to commercial stabiliser and commercial pectin ice creams, passion fruit pectin ice creams had a superior overrun and melting rate, as well as a lower viscosity. According to sensory evaluation, passion pectin provided the same texture, mouth feel, and body to icecream as the commercial stabiliser. According to physical and sensory evaluations, passion fruit endocarp pectin provided greater ice cream stabilisation and hence might be utilised as a substitute for commercial stabilisers. (Simmaky Surendran., 2019) <sup>[25]</sup>. The principal by product of passion fruit processing, passion fruit mesocarp flour (PFMF), was used to make high-fiber dried noodles. (Ning, X *et al.*, 2022) <sup>[13]</sup>.



**Fig 1:** Industrial uses of passion fruit

## Conclusion

For thousands of years, plants have been the foundation of many traditional medicines around the world, and they have continued to supply humans with new therapies. They are one of the most abundant sources of bioactive chemicals on the planet. Passion fruit is one of among them and are rich in proteins, carbohydrates, vitamins, minerals and so on. It is one of the fruit among which considered as an underutilized fruit. However, many food products have been developed from its pulp, peel and even seeds. They are renowned mainly for its juice mean while different varieties of products have been made from passion fruit including yogurt, pasta, biscuits, noodles, jam and so on. They are rich in antioxidant and including it in our diet will be a good way to strengthen our body.

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