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Diabetes and Medicinal Benefits of *Passiflora edulis*

Review Article

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Abstract

Passiflora edulis (Passion Fruit) belonging to the family *Passifloraceae* has exotic, unique flavor and aroma also known for its amazing nutritional and medicinal properties. Plants have been widely used throughout the world for their beneficial medicinal benefits. Plants are the richest sources of phyto-constituents. The review reveals the presence of wide ranges of phytochemical constituents from the plant like flavonoids, tannins, phenol, glycosides, fatty acids, alkaloids. It has been reported that *passiflora edulis* plant contains anti-inflammatory, anticonvulsant, antimicrobial, anticancer, anti-diabetic, anti-hypertensive, 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. This article briefly reviews the ethno pharmacology, phyto-constituents and medicinal benefits of the plant highlighting the need for further research and development in pharmaceutical aspects.

Keywords: *Passiflora edulis*; Medicinal Benefits; Phytochemicals; Anti - Diabteic; Anti - Hypertensive.

Introduction

Diabetes mellitus is characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both [1]. In United States 29.1(9.3%) million people of population have diabetes. It was also reported that during 2008-2009, an estimated of 18436 people younger than 20 years had type I diabetes and 5089 younger than 20 years were diagnosed with type II diabetes [2]. According to the world health organization reports, India had 32 million diabetic people in the year 2000. The prevalence of diabetes worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030 [3].

The herbal drugs with anti-diabetic activity are yet to be formulated as modern medicines commercially [4].

Passiflora edulis (Passion Fruit)

Passion fruit are grown mostly in tropical and sub-tropical part of the world. Passion fruit, a native of tropical America (Brazil), belonging to the family *Passifloraceae* is a high value and export oriented crop. Passion fruit stands out not only for its exotic and unique flavor and aroma but also for its amazing nutritional and medicinal properties.

Of the estimated 500 species of *Passiflora* in the family *Passifloraceae*, only one *P. edulis Sims*, has the exclusive designation of passionfruit, preferably seen growing at an altitude of 800-1500 m above sea level. Within this species, there are two distinct forms, the standard yellow (*Passiflora edulis f. flavicarpa Deg.*) and the purple (*Passiflora edulis f. edulis*), differing in pH and starch content between the yellow (pH 2.8 and 0.06% starch) and the purple (pH 4.2 and 0.74% starch), with comparatively higher amylose content in former (8.7%) than latter type (5.8%). In purple passion fruit,

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cool temperatures are favorable for flower initiation and fruit set (23-18°), while relatively high temperatures seem necessary for promoting juice production (23-33°C) and improvement in quality [5]. In India, passion fruit cultivation is confined to Kerala, Tamil Nadu (Nilgiri hills and KodaiKenal), Karnataka (Coorg) and northeastern states (Mizoram, Nagaland, Manipur and Sikkim) [5, 6].

Passion fruit is a highly nutrient responsive perennial crop, grows mostly as vine with a shallow root system (root density confined to top 20cm soil depth) [5]. The leaves are tri-lobed, long and deep green. These leaves are gloss on upper surface and dull on lower surface. The vine grows to a length of 15-20 feet. The fruit has circular or oval shape with membranous sac which are highly aromatic as seen inside when a fruit is cut. The sac is filled with aril (pulp) and juice. When the fruit is mature, the outer skin turn purple or yellow colour [7].

Ethno - Pharmacology

In Nagaland fresh leaves of *Passilforea edulis* is boiled in little amount of water and extract is drunk for the treatment of dysentery and hypertension [8]. The flowering and fruiting portion are dried and preserved and used as a drug in preparation of certain proprietary products. The root extracts are also used in the treatment of ulcers and haemorrhoids [9]. The root has been used as a sedative and vermifuge in West Indies, Mexico and Netherlands. In Italy the plant has been used as anti-spasmodic and sedative. In Mauritius the tincture and extract of plant has been used as a remedy for insomnia due to various nervous conditions but not due to pain. The root has been used as a diuretic and a decoction of leaves as an emetic. *Passiflora* has been used as a sedative, diuretic, anthelmintic, anti-diarrheal, stimulant and also treatment for hypertension, menopausal symptoms and colic of infants in South America. The fruit of *Passiflora edulis* is regarded as a digestive stimulant and used a remedy for gastric carcinoma. Fruits are eaten to get relief from constipation [10].

Phyto-constituents of *Passiflora edulis*

Alkaloids, phenols, glycosyl flavonoids and cynogenic compunds are known in the genus [12]. Phytochemical analysis of *passiflora edulis* revealed the presence of carbohydrates, glycosides, flavonoids, resins, alkaloids and phenolic compounds. Tannins were present in the leaf and fruit, saponins were present in the leaf and stem [12]. Organic extract (methanol, ethanol) of passiflora edulis leaves were reported to possess tannins, flavonoids, terpenoid, steroida and saponins [13, 14].

Leaf and stem of *passiflora edulis* contains new cyanogenic (2R)–â-Dallopyranosyloxy-2-phenylacetonitrile and (2S)–â-D-allopyranosyloxy-2-phenylacetonitrile along with smaller amounts of (2R)–(2S)-sambunigrin) [15]. *Passiflor edulis* has been reported to be rich in glycosides Which include flavonoid glycosides, viz., luteolin-6-C-chinovoside, luteolin-6-C-fucoside [16]. Sixteen apigenin or luteolin derivatives were characterized, which included four mono-C-glycosyl, eight-O-glycosyl and four-O-glycosyl derivatives indentifies by HPLC-DAD-MS/MS method [17].

The alkaloids present are Harman harmine, harmalol, harmol and harmaline of which the highest concentration of Harman alkaloids were found in leaves. Edulans I and Edulans II pectins were also reprted to be present in *Passiflora edulis* [18, 19]. The pigments present in the purple fruit juice are mostly carotenoids, among which β-carotene predominates [10].

The free amino acids reported in the purple fruit juice are leucines, valine, tyrosine, proline, threonin, glycine, aspartic acid, arginine, and lysine [9]. The oil seed extraction of passion fruit seed showed high levels of unsaturated fatty acids (87.59%) including mainly linoleic (73.14%) and oleic (13.83%), tocopherol (499.30mg/kg) with high percentage of carbohydrates and fiber (48.73%) [20].

Medicinal benefits of *Passiflora edulis*

Diabetes

An experimental study on albino rats of which 100, 200, 300, 400 mg/kg body weight was administered indicating % reduction of blood glucose was 6.31, 7.14, 6.73 and 6.00 respectively for each dose. It was also found that 200 mg/kg body weight was the most effective in reducing blood glucose levels with a maximum fall rate of 47.25% after 3 hours of glucose administration [21]. The presence of phenols and flavonoids may be responsible for

Nutritive value 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 fiber	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	0.130 mg	Crypto-xanthene	41 µg

(Source: USDA National Nutrient Data Base) [11]

the observed hypoglycemic activity of *passiflora edulis* [22]. On supplementation of 30g/day of *passiflora edulis flavicarpa* fruit peel flour for 60 days among type II diabetic patient, blood glucose (T0 = 162.55 ± 52.09, T60 = 120.83 ± 36.72), glycated hemoglobin (T0 = 6.58 ± 3.04, T60 = 5.71 ± 1.82) was significantly reduced. The presence of fibers, pectin which forms viscous mixture can change the gastric emptying time, increases satiety and delay the absorption of simple carbohydrates, also ability to form complexes with bile salts increases the cholesterol excretion [23].

Passion fruit has a significant content of iron, potassium, zinc and manganese. The diet contain 5% flour of passion fruit peel reduces blood glucose by 59% in diabetic rats reaching the normal glycemic amount (112.6mg/dl). The mechanism is due to the presence of fiber, tannins and phenolic compounds [24] which reduces the digestion and absorption of carbohydrates, increased the sensitivity of muscle and adipose tissue to insulin [25].

The effect of dietary fiber on insulin sensitivity is the attenuation of the glycemic response to carbohydrate through their mechanical action in the intestine where they tend to slow the absorption of nutritent [26, 27]. Passion fruit juice also helps in reduction of total cholesterol, triglyceride, LDL-C and increased HDL-C which may have beneficial effect in prevention and treatment of dyslipidemias and hyperglycemias [28]. A high intake of dietary fiber diet of 50g/day above the level of AHA recommended 24g/day for six weeks improves glycemic control, decreases hyperinsulinemia and lowers plasma lipid concentrations in type II diabetic patients [29].

Sedative and anticonvulsant

Passion fruit and its flower contain medicinal alkaloids, its phytonutrients are known to have mild sedative properties. It was found that eating passion fruit relaxes the nervous system and induces sleep [21]. The decoction of *passiflora edulis* dried leaves given to mice was found to possess sedative activity, increasing the total sleep induced by diazepam. The total sleep time increased from 31 ± 11 min in the control group to 77.6 ± 15 min and 78.3 ± 16 min in treatment group with extracts at the dose of 132.3 mg and 1325 mg/kg. CNS effect of the decoction in sedation could be interacting with benzodiazepine receptor and not GABA. Inhibitory effect on STR-induced seizure is probably on glycine and not GABA, while NMDA induced turning effect was reduced in dose dependent manner and was mediated through NMDA receptor and blocked by D-AP7. The decoction of *passiflora edulis* brought about these central actions by interacting with either inhibitory glycine or NMDA amino acid neurotransmitters. It also showed anti-convulsant activity protecting against seizure [30].

Anti-microbial activity

The petroleum ether (*passiflora edulis* leaf) crude extract at (500µg/disc) showed anti-bacterial activity of B. megaterium and P. aeruginosa. The chloroform crude leaf extracts (500µg/disc) showed moderate antibacterial activity (gram positive bacteria like B. megaterium, B. Subtilis, S. Aureus and Sarcina Lutea, gram negative bacteria like *E.Coli*, P. aeruginosa, S. Paratyphi, S. Typhi, Shigella Boydii, Vibrio Mimicus) with the average zone of inhibition of 7-10 mm by disc diffusion method [21].

The hexane extract of *passiflora edulis* leaves at 20mg/mm showed a mean diameter of inhibition zone of 16mm for S. Paratyphi, 15mm for S. Aureus, 14mm for P. Aeruginosa and 13mm for K. Pneumoniae. The flavone extract of passiflora edulis fruit and stem show inhibition of S. Aureus, P. Aeruginosa and K. Pneumoniae [12]. The aqueous extract showed zone of inhibition at a maximum concentration (200µg/disc) against *E. coli* (9.5mm), K. pneumoniae (7.2mm), P. mirablis (4.7mm), P. aeruginosa (6mm), S. flexineri (8.1mm), S. typhi (7.3mm) respectively [32].

Anti-oxidant activity

The petroleum ether and chloroform extracts of *Passiflora edulis* leaf on DPPH free radical scavenging assay showed antioxidant activity with IC50 of 58.88µg/ml and 56.85µg/ml respectively [31]. A concentration of 1100 µg mL−1 of *Passiflora edulis* leaf aqueous extract was able to scavenge 50% of DPPH radical [33]. A study reported a reduction in plasma lipid peroxidation in Wistar rats that received passion fruit juice twice a day for 28 days [34].

The leaf extract of P. edulis exhibited potential antioxidant activity exhibiting an IC50 value of 875 ± 87.83 µg/ml studied by 1,1-diphenyl-2-picryl hydrazyl radical (DPPH) quenching assay at the concentration on 1000 (µg/ml) [35]. When three different concentrations of each extract (0.1, 1 and 10 g/ml) were used in the TRAP assay to assess the antioxidant activity, there was a significant antioxidant capacity (expressed as TEAC) *in vitro* only at final concentrations of 1 and 10µg/ml. The phenolic compounds present in the extract of *passiflora edulis* might be the major contributors to the antioxidant activities [36].

Anti-cancer activity

Passion fruit contains high amount of vitamin A and vitamin C both of which are strong anti-oxidants. They neutralize free radicals and protects from cancer. The flavonoids further enhance the potency of passion fruit in providing antioxidant to body and protecting from cancer. Recent studies have also shown that in cancer patients, passion fruit can kill the cancerous cells *in vitro* studies [37]. Antioxidants in passion fruit primarily eliminate free radicals, which are known for mutating the DNA of healthy cells into cancerous ones [38]. Stock passion fruit juice showed anticancer activity on cell cycle, apoptosis and cell viability of the MOLT4 lymphoma cell line. The effect on the cell cycle was due to the presence of organic acids, amino acids and proteins in passion fruit juice [39].

Improves cardiovascular function

High potassium content with almost no sodium makes passion fruit highly effective inn protecting from blood pressure. Potassium regulates electrolyte balance and controls the muscle function of our entire body including heart muscles that create heartbeat [7]. Passion fruit contain high amount of fiber which reduces cholesterol levels in blood. It increases HDL-C and reduces LDL-C. The anti-oxidant activity of passion fruit clears the plaque formation along the inner lining of arteries [37]. A daily dose of 220mg passion fruit peel was administered to 41 type II diabetic patient to reducing cardiovascular risk and found that there was a significant reduction in blood pressure [40].

On supplementation of diet containing passion fruit mesocarp

(fiber) on diabetic rats with blood glucose level of above 120 mg/dl, a reduction in triglyceride levels was observed for GFH2O (passion fruit mesocarp fiber in water), GF15% (15% of passion fruit mesocarp fiber), and GF 30% (30% of passion fruit mesocarp fiber) groups of 26.8%, 61.7%, and 74.4%, respectively. HDL-cholesterol levels showed an 11% and 7.6% decrease in the GFH2O and GF 15% groups, while the GF 30% showed an increase of 19.1% [41]. High content of pectin in the passion fruit peel it can also induce plasma insulin and leptin secretion, in addition to its hypoglycemic and hypocholesterolemic effects. The property of insoluble fiber and other soluble constituents of yellow passion fruit (*Passiflora edulis*) attributes to reduction total cholesterol and fractions, plasma level of triglycerides, and glucose [42].

Hypertensive subjects were administered with purple passion fruit peel extract 400mg/day for four weeks and was found that the systolic and diastolic blood pressure decreased significantly by 30.9 ± 6.3 and 24.6 ± 3.3 mmHg respectively offering an alternative treatment to hypertensive patients [43]. Potassium regulates electrolyte balance and controls the muscle function of our entire body. Passion fruit is rich in potassium, which helps in regulating optimum blood pressure in the body [37].

Colon cleanser

Passion fruit contains soluble fiber which cleanses toxin stored in the colon by facilitating healthy and regular bowel movement. The antioxidants in passion fruit also aid in cleaning the colon. Fiber absorbs water and that is what makes the stools softer that are easy to pass through anal tract. The components and nutrients present in Passion fruit control and prevent constipation by adding bulk to the stools and softening them, reducing the incidence and protection from piles and inflammation of anal area, reducing the incidence and protection from piles and inflammation of anal area [37].

Vision and eye

Passion fruit is among those healthy food which is beneficial for eye, containing high amount of antioxidants like vitamin A, Vitamin C and flavonoid. Beta carotene in this fruit is known for its positive effect on eye and its vision. Phytonutrients like xanthin and beta carotene are highly effective in optimizing the immune function of our body. Vitamin C is particularly known for alleviating cold and cough. The loss of vitamin C from the body can be replenished by fruits like passion fruit [37, 38].

Increased hemoglobin

Passion fruit contains high amount of iron which is 20% of daily required value along with vitamin C. Vitamin C is vital for absorption of iron in the body. It prevents loss of iron and increases hemoglobin in the blood [37].

Digestion and intestinal health

Passion fruit is a rich source of dietary fiber, both soluble as well as insoluble fiber. Insoluble fiber helps in bowel movement and cleaning the digestive system. Consumption of insoluble dietary fiber also helps in lowering pH and ammonia content of the caecum [7]. The rind from the yellow colored passion fruit also helps in protections against diverticula disorders. Passion fruit has high water content with rich amount of fiber which helps and improves digestion. It stimulates digestion with the help of enzymes that increases the amount of digestive juices produced in stomach [37].

Asthma

The flavonoids of purple passion fruit have been found to be particularly effective in bringing the asthma symptoms in control. Flavonoid and anti-oxidant present in passion fruit peel alleviates the symptoms of asthma such as wheezing, coughing and shortness of breath. Patients with asthma were studied in a 4-week with oral administration of *Passiflora edulis* peel extract (150mg/d) or placebo pills of which the prevalence of wheeze, cough, as well as shortness of breath was reduced significantly [44, 45].

Osteoarthritis

Thirty-three osteoarthritis patients were supplemented 150mg/day of *passiflora edulis* peel extract for 2 months using WOMAC Osteoarthritis Index. At 60 days, reductions of 18.6%, 18%, 19.6%, and 19.2% in pain, stiffness, physical function, and composite WOMAC score, respectively due to the presence of antioxidant and anti-inflammatory properties present in passion fruit peel [46].

Conclusion

When considering the health benefits of *Passiflora edulis*, with the presence of phytoconstituents like Alkaloids, phenols, glycosyl flavonoids, cynogenic compounds and its anit-oxidant properties can be utilized in the treatment and prevention of Diabetes mellitus and cardiovascular diseases. With the availability of *passiflora edulis* in northeastern states on India with its bioactive constituents, efforts can be made in pharmaceutical drug development with further research on clinical trials, incorporating as food supplement for the treatment of diseases such as anxiety, as anti-diabetic, cardiovascular diseases, sedative, convulsive, asthma, osteoarthritis, anti-cancer, colon cleanser.

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