Bioactivities of Passion Fruit

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Abstract: Passion fruit possesses several bioactivities. The juice, seed and peel of passion fruit showed antioxidant properties. Besides, passion fruit peel extract and pulp could reduce blood pressure. Some compounds in passion fruit seed inhibited the growth of fungi in a dose-dependent manner. Additionally, the anti-diabetic properties of passion fruit could be observed in passion fruit juice, pectin, peel flour, seeds and mesocarp fiber. Passion fruit could also reduce inflammation. In this paper, bioactivities of passion fruit were summarized.

Keywords: passion fruit; bioactivity; antioxidant activity; antihypertension; anti-fungus; anti-diabetes; anti-inflammation.

1. Introduction

The passion fruit tree (Passiflora edulis) belongs to family Passifloraceae (Do Nascimento et al., 2016). There are two recognized forms of edible passion fruit: purple and yellow (Pruthi, 1965). The purple passion fruit is native of tropical America while yellow passion fruit is considered as a mutation of purple variety, or as a natural hybrid between purple and another related species of passion fruit (Strohalm et al., 2007; Watson et al., 2008). Purple variety is mainly grown for fresh juice and its
flavour is a vital attribute which make the juice a desirable ingredient for many formulated beverages (Farid et al., 2010). The unique flavour of passion fruit is attributed to several volatile compounds which get deteriorated with the increase in temperature (Strohalm et al., 2007). Passion fruit contains low protein (4.6%) and fat (0.6%), but it is rich in fibers (35–90% of dry matter) and compounds with antioxidant activity (Sousa et al., 2011; Hernandez-Santos et al., 2015). Several bioactive compounds, such as quercetin, luteolin, and cyanidin 3-O-glucoside have been identified (Farid et al., 2010; Ayala-Zavala et al., 2011). These compounds possess high antioxidant activity, and could be used as a source of food ingredients for the development of functional foods (Oliveira et al., 2002; Contreras-Calderon et al., 2011; Martinez et al., 2012; Lopez-Vargas et al., 2013). Passion fruit has shown several bioactivities, such as antioxidant, antihypertension, anti-fungus, anti-diabetes and anti-inflammation activities. This paper summarized bioactivities of passion fruit, and special attention was paid to the mechanism of action.

2. Bioactivities

2.1. Antioxidant Properties

The antioxidant properties of passion fruit depend on cultivar, ripeness, and different parts of the fruit. The total antioxidant activity of fruit juices from vine-ripened purple and yellow P. edulis in seven common species was tested, and the range was 409.13-586.70 µmol Trolox/L (Devi Ramaiya et al., 2013). For passion fruit seed, ethyl acetate (EtOAc) is a better extraction reagent than water (Lourith et al., 2013). The IC50 DPPH of EtOAc extract was 2.7 ± 0.2 µg/mL, and IC50 ABTS of EtOAc extract is 9.0 ± 0.0 µg/mL. After treatment with passion fruit peel, the serum and tissue antioxidant status on people with inflammatory bowel disease was improved (Cazarin et al., 2014). In double-blinded research, passion fruit peel substantially alleviated pain, stiffness, physical function, and composite WOMAC score in osteoarthritis patients partly because of its antioxidant properties (Farid et al., 2010).

2.2. Antihypertensive Properties

The antihypertensive properties of passion fruit were observed in spontaneously hypertensive rats (SHRs). Passion fruit peel extract and pulp could both reduce blood pressure of SHRs (Ichimura et al., 2006). The authors considered that γ-Aminobutyric acid (GABA) is the most important component in passion fruit peel to induce antihypertensive effect in SHRs because the extract contained a relatively high concentration of GABA. However, another research drew a different conclusion. The edulilic acid (EA) and anthocyanin fraction (AF) significantly reduced all measured hemodynamic
parameters from baseline when compared to control, but GABA did not significantly affect any hemodynamic parameters compared to control and significantly increased heart rate (Lewis et al., 2013). Since Lewis' paper provided the potential actives at equivalent doses to those found in 50 mg Passiflora edulis peel extract/kg body weight, Lewis' conclusion is more convincing and the EA and AF play the most important roles in reducing blood pressure in SHRs. In addition, passion fruit pulp significantly reduced the systolic blood pressure, increased the glutathione (GSH) levels and decreased thiobarbituric acid-reactive substances (TBARS) (Konta et al., 2014). The paper attributed the lower blood pressure effect to the enhancement of the antioxidant status but failed to explain the exact mechanisms.

2.3. Anti-fungal Properties

It has become increasingly clear that antimicrobial proteins play an important role in the protection of plants and their seeds. There are also some anti-fungal proteins extracted from seeds of the passion fruit. Two proteins, named Pf1 and Pf2, inhibited the growth of the phytopathogenic fungi in a dose-dependent manner in a vitro assay (Agizzio et al., 2003). These proteins were also subjected to automated N-terminal amino acid sequence, showing high degree of similarities to storage 2S albumins, adding a new member to this protein-defence family (Pelegrini et al., 2006).

2.4. Anti-diabetic Properties

The anti-diabetic properties of passion fruit could be observed in passion fruit juice, pectin, peel flour, seeds and mesocarp fiber. After treatment with passion fruit juice, diabetic Wistar rat offspring showed the effect of preventing and treating dyslipidemias and hyperglycemia (Barbalho et al., 2011). Research on healthy adult male Wistar rats found the use of passion fruit juice showing beneficial effects on lipid profile and improving lipid peroxidation (de Souza Mda et al., 2012). Passion fruit pectin showed hypoglycemic and hypotriglyceridemic properties in diabetic rats (Silva et al., 2011). In type 2 diabetic patients, insulin resistance is the main cause of diabetic, and passion fruit peel flour was found to decrease insulin resistance. A significant difference was observed in the fasting blood glucose values (P = 0.000) and glycated hemoglobin (P = 0.032) after dietary supplemented yellow passion fruit peel flour (de Queiroz Mdo., 2012). Additionally, passion fruit seed showed anti-diabetic property. An ingredient in passion fruit seed named piceatannol could reduce fasting blood glucose level (Uchida-Maruki et al., 2015). Mesocarp fiber of passion fruit at concentrations of 15% and 30% was used to diabetic rats induced by alloxan (2%), and the result showed that the fiber had potential hypoglycemic effect (Correa et al., 2014). In all, the anti-diabetic properties of passion fruit embodied in hypoglycemic, hypotriglyceridemic effect and decreasing insulin resistance effect.
2.5. Anti-inflammatory Properties

Some experiments in rats proved that passion fruit leaves extract had positive influence in wound healing. Gonçalves Filho et al. (2006) tried to see the influence in rats’ bladder wound and explored the mechanisms. Finally, they concluded that the extract promoted wound healing because it could reduce acute inflammation. The mechanisms were explained in a test in the mouse model of pleurisy. Passion fruit leaves extract’s anti-inflammatory properties were because of the inhibition of pro-inflammatory cytokines (TNF-α, IL-1β), enzyme (myeloperoxidase) and mediators (bradykinin, histamine, substance P, nitric oxide) release and/or action (Montanher et al., 2007). But in another research, anti-inflammatory effect showed in the mouse model of pleurisy could be explained because leukocyte migration was inhibited and the formation of exudate was reduced (Vargas et al., 2007). Passion fruit peel extract treatment significantly attenuated extensive inflammatory cell infiltration and accumulation of collagen in lung tissue sections of bleomycin-induced mice (Chilakapati et al., 2014). Silva et al. (2015) isolated a polysaccharide fraction from passion fruit and proved that it could inhibit the inflammatory response in mice. Their results suggested that this polysaccharide fraction reduced the inflammatory response by modulation of the liberation or synthesis of histamine and serotonin, by reduction of neutrophil migration, IL-1β levels, and oxidative stress and nociception.

2.6. Melanogenesis Inhibition Properties

Several ingredients were proved to have melanogenesis inhibition properties. It is found that treating melanoma cells with passion fruit seed extraction led to inhibition of melanogenesis and the removal of polyphenols from the extraction led to the abolishment of the effects, which indicated that polyphenols was the major component responsible for the effects observed on melanogenesis (Matsui et al., 2010). However, Jorge et al. (2012) discovered Schinus terebinthifolius Raddi extract and linoleic acid from Passiflora edulis oil synergistically decreased melanin synthesis in B16 cells. The whitening effect of these compounds was assessed using biochemical assays and in vitro models including cellular assays and equivalent skin, and the combination of these two compounds might provide a synergistic positive melanogenesis inhibition effect rather. The leaves of passion fruit contained a glycosidic inhibitors of melanogenesis and in an experiment, it exhibited inhibitory effects with 37.3-47.2% reduction of melanin content with almost no toxicity to the cells (90.8-100.2% cell viability) at 100 µM (Zhang et al., 2013). Their experiment suggested that this compound inhibited melanogenesis by inhibiting the expression of MITF, followed by decreasing the expression of TRP-1 and tyrosinase.

2.7. Anxiolytic/Sedative Properties
Passion fruit could be used as anxiolytic/sedative food with little adverse reaction. The aqueous extract of passion fruit presented an anxiolytic-like activity without any significant effect upon the motor activity whilst the total flavonoid fraction presented an anxiolytic-like activity but compromised motor activity (Coleta et al., 2006). Another study confirmed that the aqueous extracts of *Passiflora edulis*, similar to diazepam, reduced anxiety-related behaviors without affecting memory process in rats (Barbosa et al., 2008). In an experiment, Swiss albino mice were used as experimental animal, a sedative-like activity was produced at higher doses than anxiolytic-like activity and flavonoids could active constituents. Wang et al. (2013) did a further research and they verified a constituent named cycloartane triterpenoid in passion fruit to be one of the main compositions with antidepressant-like activity.

2.8. Cardiovascular Protection Properties

Cardiovascular protection properties of passion fruit could be attributed to a component in passion fruit seed which has been mentioned above, named piceatannol. This component could also reduce fasting blood glucose levels. One study by Sano et al. (2011) introduced a dimer of piceatannol, named scirpusin B. The vasorelaxant effects of scirpusin B were determined ex vivo in rat thoracic aorta, in which it exhibited significant vasorelaxant effects. More specifically, scirpusin B exerted a greater vasorelaxant effect compared with piceatannol. Another study by Kinoshita et al. (2013) tried to explain the mechanism of vasorelaxing properties. Their findings indicated that piceatannol regulated the blood vessel by up-regulating eNOS expression, which suggested that piceatannol might be a novel therapeutic agent for the prevention of cardiac hypertrophy because piceatannol regulated the expression and binding of the transcription factor GATA binding factor 6 (Kee et al., 2014).

2.9. Other Properties

There are some other properties of passion fruit have been revealed. Piceatannol is also reported to have anti-photoageing properties (Maruki-Uchida et al., 2013). Passion fruit juice could inhibit neoplastic transformation (Rowe et al., 2004). Passion fruit extraction showed antiviral activity (Müller et al., 2007). Dietary fiber components in yellow passion fruit rind could protect against diverticular diseases (Yapo and Koff, 2008).

3. Conclusions and Prospects

Passion fruit showed several bioactivities, such as antioxidant, antihypertension, anti-fungus, anti-diabetes and anti-inflammatory activities. The different bioactivities of passion fruit were not completely independent, and some effects could be explained both by antioxidant properties and anti-
inflammatory properties. In the future, more studies are needed to find new bioactive compounds and biological activities of passion fruit, and special attention should be paid to the mechanism of action.

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