The antioxidant activitives of mango peel among different cultivars

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Abstract. In this paper, the contents of total phenol and total flavonoid of 8 mango cultivars were determined. Their antioxidant abilities were also evaluated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP). Correlations between total phenol, total flavonoid and FRAP as well as TEAC were also analyzed. Results showed that mango peels were rich in natural antioxidant compounds the antioxidant abilities were different among different cultivars. The correlations between total phenol, total flavonoid and FRAP indicated phenolics represent a major part of antioxidant capacity in mango peels. This was also useful in the utilization of mango processing waste.

1. Introduction

Mango (Mangifera indica L.) is a widely planted and consumed tropical fruit throughout the world. Besides the fresh fruit, mango can also be processed into juices, nectars, concentrates, jams, jelly powders and so on.

It has been reported that fruits and vegetables contain many antioxidant compounds, such as phenolic compounds, carotenoids, anthocyanins and so on (Naczk and Shahidi, 2006). Among the different parts, fruit peels are rich in polyphenolic compounds, flavonoids, ascorbic acid, and this makes them valuable in making antioxidants.

There has been increasing focus of attention of many researchers searching for potent antioxidants from mango. Different parts of mango, including stem bark, leaves, pulp and peel have been investigated. Results showed that those parts possessed various biomedical activities, including antioxidative, free radical scavenging, anti-inflammatory, and anticancer ((Ajila et al 2007; Rocha Ribeiro et al., 2007; Hernandez et al 2007; Percival et al., 2006; Ling et al, 2009).

Peel is a major by-product of mango processing, and they are discarded as waste. It has been reported that peel was a good source of phytochemicals, such as polyphenols, carotenoids, and it exhibited good antioxidant properties (Ajila et al 2007; Kim et al, 2010). It is commonly considered that the concentration and composition of phenolics is affected by genetic, agronomic and environmental factors (Tomás-Barberan and Espin, 2001). However, the antioxidant activities regarding differences among different mango cultivars have been rarely reported.

In this paper, the contents of total phenol and total flavonoid of 8 mango cultivars were determined. Their antioxidant abilities were also evaluated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging, trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP). Correlations between total phenol, total flavonoid and FRAP as well as TEAC were also analyzed. The results showed that mango peels were rich in natural antioxidant compounds the antioxidant abilities were different among different cultivars, and this was useful in the utilization of mango processing waste.
2. Materials and methods

2.1. Materials and regents
Ripen fruits of 8 mango cultivars in China, namely ‘Chenpixiang’, ‘Boluoxiang’, ‘Qiumango’, ‘Zaoshumango’, ‘Hong kaite’, ‘Hongmango 6’, ‘Sijimango 1’, and ‘Jinhuang’ (designated as 1-8 in this research) were collected just from the trees planted in South Subtropical Crop Research Institute. 10 fruits of each cultivar were picked and cleaned with water, then the peels were collected and then ground using a stainless-steel grinder. They were stored in vacuum-packaged polyethylene pouches at -20°C until required for analysis.

Folin-Ciocalteu’s (FC) phenol reagent and gallic acid (GA) were purchased from Fluka. The 1,1-diphenyl-2-pireyhydrazyl (DPPH) and 2,2’-amino-di(2-ethyl-benzothiazoline sulphonic acid-6) ammonium salt (ABTS) radical and all other standards were received from Sigma-Aldrich.

2.2. Sample extraction
1 g mango peel of different cultivars was weighed and refluxed with 30 ml of 70% methanol at 60 °C for 2 h under magnetic stirring. The filtrate was separated by centrifugation, and the extraction was repeated for 3 times. All the filtrate was collected and concentrated under reduced pressure at 40 °C with a final volume of 30 ml and the solution used in the following evaluation and detection.

2.3. Determination of total phenolic content and total flavonoid in the extracts
The total phenol content (TPC) was determined using the FC assay described before with some modifications (Du et al., 2014). Typically, 0.025 ml of the extract of different cultivar was introduced into test tubes and followed by the addition of 2.0 ml of FC reagent (diluted 10 times with water in advance) and 5.975 ml of water. The solutions were allowed to stand 5 min at room temperature before the addition 2 ml of sodium carbonate solution (7.5% w/v). After reacting in dark for 30 min at room temperature, the absorbance of the solutions were measured at 760 nm on a UV–vis spectrophotometer (Shimadzu UV-2700, Japan). The calibration curve was prepared using a standard solution of gallic acid. The results were expressed as milligram gallic acid equivalents (GAE)/g dry weight (fresh weight, FW).

Total flavonoid content was determined based on the method described by Kim et al (Kim et al., 2003). One milliliter of extract solution of different cultivar was mixed with 0.3 ml of 5% NaNO₂ and 4 ml of distilled water. Then 0.3 ml of Al(NO₃)₃ was added to the mixture followed by adding 2 ml of 1 M NaOH. The solution was immediately diluted to 10 ml using distilled water. The absorbance of the solution was measured at 506 nm and the total flavonoid content was calculated by using a calibration curve of rutin standard and expressed as mg rutin equivalent (QR Equiv)/g FW.

2.4. DPPH radical scavenging ability
The free radical scavenging activity of the extracts was performed by measuring the decrease in absorbance of DPPH solution at 517 nm in the presence of the extracts by the method proposed by Liya-Pathirana et al (2010) with minor changes. The solution of 0.5 mM was prepared by dissolving DPPH in methanol. For the evaluation of free radical scavenging activity, 3 ml of DPPH was added into 0.5 ml of the extracts with different concentrations. The mixture was then allowed to stand at room temperature for 30 min in dark before the absorbance at 517 nm was read. The control was prepared as above without extract. The antioxidant activity could be expressed as the following equation:

\[
\text{Scavenging activity} = \frac{A_0 - A_s}{A_0} \times 100\%
\]

where A₀ and Aₕ were the absorbance at 517 nm of the control and sample solution, respectively.

2.5. Trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP)
This assay was determined according to the method reported (Benzie et al., 1996). For the determination of FRAP, the extracts (10 μL) were mixed with 1 ml distilled water and 1.8 ml of the FRAP solution. Then the mixture was reacted at 37 °C for 10 min. The absorbance of the reaction solution was recorded at 593 nm. Trolox standard solution was used to perform the calibration curves and the results were expressed as μM trolox/g (fresh weight, FW).

TEAC was calculated according to the ABTS scavenging ability of mango peel extract. This was performed by the procedure described by Re et al (1999). For the scavenging of ABTS, 50 μl of different extracts were added to 4 mL of the solution above. Methanol was used as control. After reaction for 10 min, the absorbance was measured at 734 nm. The free radical scavenging capability was calculated by the equation:

\[ \text{ABTS scavenging activity} = \frac{(Ac - As)}{Ac} \times 100\% \]

where Ac and As were the absorbance at 734 nm of the control and sample solution, respectively. Trolox standard solution was used to perform the calibration curves and the results were expressed as μM trolox/g (FW).

3. Results and disscussion

3.1. Contents of total phenol and total flavonoid

The contents of total phenol and total flavonoid in each cultivar was summarized in table 1. It can be conclude from the table that the total phenol and total flavonoid ranged from 1.68-13.28 and 0.33-6.08 mg/g, respectively. The cultivar ‘Chenpixiang’ possessed the highest while ‘Jinhuang’ possessed the lowest contents of total phenol and total flavonoid. This indicated that the bioactive compounds in mango peels varied greatly different mango cultivars. Similar results have been reported in litchi pericarps (Wang et al, 2011).

| cultivars | 4 | 5 | 6 | 7 | 8 |
|-----------|---|---|---|---|---|
| Total phenol (mg/g) | 12.34 | 9.44 | 7.74 | 6.84 | 6.19 | 5.14 | 1.68 |
| Total flavonoid (mg/g) | 6.08 | 5.32 | 4.13 | 4.26 | 1.65 | 2.42 | 1.67 | 0.33 |
| FRAP (μM/g) | 122 | 96 | 82 | 78 | 58 | 42 | 39 | 16 |
| TEAC (μM/g) | 185 | 184 | 168 | 98 | 109 | 65 | 62 | 58 |

3.2. Antioxidant activities of mango peel extracts

Due to its operating simplicity, DPPH is one of the most popular methods employed for the evaluation of antioxidant ability, especially in plant extract. DPPH is a kind of stable organic radical. In the radical form, the molecule of DPPH has an absorbance at 517 nm, which will disappear after the acceptance of an electron or hydrogen radical from an antioxidant in the solution to become a stable diamagnetic molecule (Matthäus, 2002).

The DPPH scavenging ability of the peel extracts of different mango cultivars was given in Figure 1. Different from the results of total phenol and total flavonoid, there was no obvious difference among those values. This may because that the bioactive compounds which could scavenge DPPH might almost be the same in different mango cultivars.

The values of FRAP and TEAC were also given in table 1. It can be seen that FRAP of mango peel extract of different cultivars ranged from 16 to 122 μM/g, and the turn was the same as that of total phenol and total flavonoid. This was because FRAP represented the total antioxidant activity of plants, and it was only connected to the total bioactive compounds. The turn of TEAC was not totally in accordance with that of FRAP, and this may be ascribed to the same reason of DPPH scavenging ability.
3.3. Correlations

Correlations were made in order to determine the contribution of total phenol and total flavonoid to the antioxidant activities of mango peel. The correlation between total phenol and FRAP, TEAC was shown in Figure 2A. It can be seen that the correlation between total phenol and FRAP was almost linear ($r^2=0.92$). The trend was the same of the correlation between total flavonoid and FRAP ($r^2=0.94$). This indicated that phenols and flavonoids represent a major part of antioxidant capacity in mango peel. However, the correlation coefficients between total phenol, total flavonoid and TEAC were lower than those of FRAP ($r^2=0.69, 0.84$, respectively), and this may be due to the fact that TEAC were calculated from the ABTS scavenging ability. Different from FRAP, the ABTS scavenging ability could not represent the total antioxidant capacity of mango peels.

4. Conclusions

The contents of total phenol and total flavonoid of mango peels of 8 different cultivars, namely ‘Chenpixiang’, ‘Boluoxiang’, ‘Qiumango’, ‘Zaoshumango’, ‘Hong kaite’, ‘Hongmango 6’, ‘Sijimango 1’, and ‘Jinhuang’ were determined and compared in this research. Their antioxidant abilities were also evaluated by DPPH radical scavenging and FRAP. Results showed that the turns of total phenol and total flavonoid were both ‘Chenpixiang’>‘Boluoxiang’>‘Qiumango’>‘Zaoshumango’>‘Hong kaite’>‘Hongmango 6’>‘Sijimango 1’>‘Jinhuang’. The turn of values of FRAP was the same as that of total phenol and total flavonoid, and the highest and lowest were 122 and 16 μM/g, respectively. This may because FRAP the total antioxidant activity of plants, and it was only connected to the total

Figure 1 DPPH scavenging abilities of the peel extracts of different mango cultivars.

Figure 2 Correlations of (A) total phenol and FRAP, TEAC, (B) Total flavonoid and FRAP, TEAC.
bioactive compounds. The correlation between total phenol, total flavonoid and FRAP was almost linear, and this was of the same reason above. There was no change among the DPPH radical scavenging abilities of different cultivars, and the turn of TEAC was not totally in accordance with that of FRAP. The reason of this may be that DPPH and TEAC only represented their radical scavenging abilities. Besides, the correlation was not linear. All these indicated that the antioxidant activities mainly came from total phenols and total flavonoids. The research showed that mango peels were rich in natural antioxidant compounds and the antioxidant abilities were different among different cultivars, and phenols represent a major part of antioxidant capacity in mango peels. The results were also helpful in the utilization of mango processing waste.

Acknowledgements
The research was supported by the National Natural Science Foundation of Hainan province (No. 20153122) and the Fund on Basic Scientific Research Project of Nonprofit Central Research Institutions (No. 1630062016008).

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