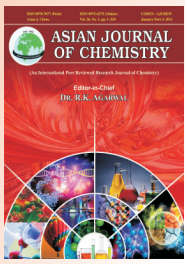
Asian Journal of Chemistry; Vol. 26, No. 16 (2014), 5313-5314

ASIAN JOURNAL OF CHEMISTRY

http://dx.doi.org/10.14233/ajchem.2014.16275



*NOTE*

# Phenolic Compounds in Bitter Melons Collected from Different Regions of Korea

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*Received*: 3 September 2013; *Accepted*: 27 December 2013; *Published online*: 28 July 2014; AJC-15686

In this paper, we described the variation in levels of phenolic compounds from bitter melon fruits, as analyzed for the first time by high-performance liquid chromatography. The plants were grown under controlled conditions from seeds collected from six different locations in Korea. Catechin was present at much higher levels than any other phenolic compound; the other compounds, in order by amount, were benzoic acid, 4-hydroxy-3-methoxy benzoic acid, *p*-coumaric acid, *trans*-cinnamic acid, ferulic acid and kaempferol. The bitter melon from Kumsan contained the highest amounts of catechin, benzoic acid and *trans*-cinnamic acid, whereas the bitter melon from Namwon contained the lowest amounts of catechin and most of the other phenolic compounds. The quantity of catechin was 2.43 times as high in the Kumsan sample as in the Namwon sample. Our results suggest that the bitter melon grown in Kumsan is the best potential source of phenolic compounds.

**Keywords: Phenolic compounds, Catechin, *Momordica charantia*, Bitter melon.**

*Momordica charantia* Linn, belonging to the Cucurbitaceae family, is an indigenous medicinal plant and vegetable found in temperate and tropical regions of Asia and other areas of the world, commonly known as bitter melon or bitter gourd because of its taste. The oblong, cucumber-like fruit is emerald-green when young and turns orange-yellow when ripe[1,2].

The nutritional quality of bitter melon has been investigated and several classes of primary and secondary metabolites have been isolated from *M. charantia* fruit, seeds and whole plants since the early 1960s. In many countries, bitter melon is used to treat diabetes and colic and as a carminative[3-5]. The immature fruits are a good source of vitamin C and also provide vitamin A[6-8]. The fruit and seeds of bitter melon are used as traditional medicine for their anti-HIV, antiulcer, antiinflammatory, antileukemic, antimicrobial, antidiabetic and antitumor properties[9-13].

Levels of phenolic compounds in vegetables vary considerably according to plant location. Reliable assessments of phenolic compounds in bitter melon are needed in order to accurately quantify dietary intake of these important compounds. This is the first study to use high-performance liquid chromatography (HPLC) to analyze phenolic compound levels in bitter melon from different regions of Korea.

Seeds of *Momordica charantia* were collected from six different regions in Korea (Kumsan, Sangju, Janghueng, Namwon, Chuncheon and Suwon) and stored at 4 °C. Seeds were germinated in a growth chamber, after which the seedlings were transferred to the experimental farm at Chungnam National University, Daejeon, Korea. Fruits were harvested from the 4-month-old plants for chemical analysis of phenolic compounds.

**Sample preparation:** Fresh fruit samples were dried in a freeze-dryer at -80 °C for at least 48 h. Dried samples were ground into a fine powder using a mortar and pestle. Samples were extracted according to the procedure described by Kim *et al.*[14]. Fine-ground samples were extracted twice with 80 % methanol for 1 h at room temperature. The solution was filtered through a poly filter (pore size, 0.45 μm) and then diluted 2-fold with methanol prior to undergoing HPLC analysis.

**HPLC analysis:** Quantification of seven phenolic compounds by HPLC was done with a Futecs model NS-4000 HPLC apparatus using a C18 column (250 mm × 4.6 mm, 5 μm; RStech, Daejeon, Korea). The mobile phase was prepared from mixtures of acetonitrile and 0.15 % acetic acid and the column was maintained at 30 °C. A 20 μL-sample from the methanol-solubilized extract was injected and phenolic compounds were

TABLE-1
VARIATION OF PHENOLIC COMPOUNDS IN BITTER MELON FROM DIFFERENT REGIONS OF KOREA

| Phenolic compound (μg/100 mg DW) | Regions | | | | | |
|---|---|---|---|---|---|---|
| | Kumsan | Sangju | Janghueng | Namwon | Chuncheon | Suwon |
| Catechin | 2.26 ± 0.15 | 1.58 ± 0.21 | 1.31 ± 0.10 | 0.93 ± 0.08 | 0.98 ± 0.10 | 1.12 ± 0.07 |
| 4-Hydroxy-3-methoxy benzoic acid | 0.26 ± 0.02 | 0.33 ± 0.05 | 0.25 ± 0.01 | 0.15 ± 0.01 | 0.18 ± 0.03 | 0.17 ± 0.02 |
| *p*-Coumaric acid | 0.13 ± 0.00 | 0.11 ± 0.00 | 0.14 ± 0.01 | 0.06 ± 0.00 | 0.14 ± 0.00 | 0.07 ± 0.01 |
| Ferulic acid | 0.31 ± 0.01 | 0.00 | 0.24 ± 0.00 | 0.00 | 0.28 ± 0.03 | 0.38 ± 0.03 |
| Benzoic acid | 0.60 ± 0.09 | 0.51 ± 0.02 | 0.42 ± 0.03 | 0.46 ± 0.06 | 0.31 ± 0.02 | 0.66 ± 0.08 |
| *trans*-cinnamic acid | 0.08 ± 0.01 | 0.06 ± 0.01 | 0.03 ± 0.00 | 0.04 ± 0.00 | 0.03 ± 0.00 | 0.03 ± 0.01 |
| Kaempferol | 0.17 ± 0.00 | 0.15 ± 0.00 | 0.13 ± 0.00 | 0.00 | 0.23 ± 0.01 | 0.00 |

detected at 280 nm with a Waters tunable absorbance detector. The column flow rate was 1 mL/min with a 40 min total run time for each sample. The results were calculated using a standard curve. All samples were run or replicated three times.

The results of the analysis of phenolic compounds appear in Table-1. Of the seven phenolic compounds analyzed, catechin was present in the greatest amount, followed by benzoic acid. The catechin content ranged from 0.93 μg/100 mg DW (Namwon) to 2.26 μg/100 mg DW (Kumsan), a 2.43-fold difference. The benzoic acid content ranged from 0.31 μg/100 mg DW (Chuncheon) to 0.66 μg/100 mg DW (Suwon), a 2.13-fold difference. The third most plentiful phenolic compound was 4-hydroxy-3-methoxy benzoic acid. Its content ranged from 0.15 μg/100 mg DW (Namwon) to 0.33 μg/100 mg DW (Sangju), a 2.2-fold difference. The levels of *p*-coumaric acid ranged from 0.06 μg/100 mg DW (Namwon) to 0.14 μg/100 mg DW (Janghueng), a 2.33-fold difference. *trans*-cinnamic acid ranged from 0.03 μg/100 mg DW (Janghueng, Chuncheon and Suwon) to 0.08 μg/100 mg DW (Kumsan), a 2.67-fold difference. Ferulic acid was not detected from the samples from Sangju and Namwon. The highest and the lowest amounts of ferulic acid were found in the bitter melon from Suwon (0.38 μg/100 mg DW) and Janghueng (0.24 μg/100 mg DW), respectively. Kaempferol was not detected in the samples from Namwon and Suwon. Bitter melon grown from seeds collected in Kumsan contained the highest amounts of catechin, benzoic acid and *trans*-cinnamic acid, whereas for most of the compounds the bitter melon grown from seeds collected in Namwon contained the smallest amount of phenolic compounds.

This study is the first quantitative analysis of phenolic compounds in the fruits of bitter melon from varying locations in Korea. Our results show that the amount of phenolic compounds varied widely among the samples. They varied among samples grown from seeds from the same locations, as well as among samples grown from seeds collected in different locations. No single location yielded the highest amounts of all the phenolic compounds. For example, bitter melon from Kumsan contained the highest amounts of catechin, benzoic acid and *trans*-cinnamic acid, but not the highest amounts of some other compounds. Similar findings were reported by Uddin *et al.*[15], who found that the phenolic compounds in tartary buckwheat significantly varied among cultivars from different origins. Likewise, mineral content varies with species, cultivar, geographical location of harvest, season, environmental factors, the method of mineralization and physiological factors[16-19].

## Conclusion

The levels of phenolic compounds in the fruits of bitter melon from different locations varied widely. Bitter melon from Kumsan had the highest levels of most of the phenolic compounds analyzed. Location-specific phenolic compound profiles may help guide commercial production of phenolic compounds.

## ACKNOWLEDGEMENTS

This work was supported by the research grant of the Kongju National University in 2013.

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