Biochemical and antioxidant quality of fruits of blood orange, kumquat and grapefruit

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Introduction

In addition to providing significant amounts of nutrients in our diet, plants reduce the risk of many diseases. The beneficial effects of their consumption are due to the presence of various antioxidant compounds such as vitamin C, polyphenols and flavonoids. Plants are a rich source of antioxidants that increase human health and maintain the quality of foods (Rice-Evans *et al.*, 1996). Antioxidants are compounds that can neutralize free oxygen radicals (Hodges, 2003). Antioxidants are active in both enzymatic and non-enzymatic ways in plants. Enzymatic antioxidant system includes superoxide dismutase (SOD), guaiacol peroxidase (POD), catalase (CAT) and glutathione reductase (GR). Non-enzymatic antioxidant systems include ascorbate, glutathione, vitamin E, carotenoids and non-photosynthetic pigments such as anthocyanins, flavonoids and phenolic compounds (Singh *et al*., 2007; Felsot, 2004).

Anthocyanins are mostly found in colored crops such as strawberries, apples, cherries, raspberries, oranges, grapes, figs, mangoes, pomegranates, red cabbage and sweet potatoes (Lee *et al*., 2005). The amount of carotenoids and phenolics in tangerine cultivars was higher than orange varieties (Su *et al*., 2008; Abeysinghe *et al*., 2007).

Materials and Methods

The antioxidant properties of fruits are directly related to the presence of these compounds in plants. For this purpose, a study was conducted to evaluate the biochemical and antioxidant quality of blood orange, kumquat and grapefruit fruits. In this study, data of blood orange "Moro", kumquat and grapefruit were analyzed in three replications. Evaluated traits included: protein, vitamin C, anthocyanin, antioxidant capacity, catalase, peroxidase, polyphenols and flavonoid content.

Protein measurement carried out by the Bradford method at a wavelength of 595 nm by a SHIMADZO 160-UV spectrophotometer (Askari *et al*., 2012). Vitamin C was measured by titration with dichlorophenol-indophenol (Ladaniya, 2008). To calculate the concentration of flavonoids, the extinction coefficient (ε =33000 mol/cm) was used (Humadi *et al*., 2008). Peroxidase activity was evaluated by Addy and Goodman (1972) method.

The statistical analysis of the data was based on a completely randomized design with three replications using MSTATC software and the comparison of the means conducted with

the LSD test, and SPSS was used to estimate the correlation (Pearson's correlation coefficient).

Results and discussion

The results showed that the highest amount of protein, polyphenols and anthocyanin was found in blood orange fruit, the highest amount of vitamin C and peroxidase was related to kumquat and the highest amount of flavonoids, catalase and antioxidant capacity was obtained from grapefruit.

Based on data analysis of variance, a significant difference was observed between citrus types in ascorbic acid content. The mean comparison shows that kumquat had the highest content of ascorbic acid (104.6 mg/100g FW) and blood orange had the lowest content of ascorbic acid (83.37 mg/100g FW). Keshavarz (2011) found that the content of ascorbic acid in the flesh and peel of kumquat fruits was higher than other citrus fruits, which is consistent with the present results.

Based on the mean comparison, the highest polyphenol content (1.67 mg/100 g) was related to blood orange and the lowest content was related to kumquat. The highest phenolics content in this study was related to blood oranges, which is consistent with the results of Ghasemi *et al*., (2009) in citrus fruits. Analysis of variance showed that there was a significant difference between antioxidant capacity of studied the cultivars (p <0.01). Mean comparison shows that the highest amount of antioxidant capacity (60.97% DPPH) was related to grapefruit and the lowest amount of antioxidant capacity was related to blood orange (50.23% DPPH) and kumquat (30. 50% DPPH).

Correlation of experimental traits showed that the relationship between the amount of vitamin C with antioxidant capacity, flavonoid (270 nm) and phenolics was significant and this relationship was negative. But there was a positive and significant correlation between the amount of vitamin C and peroxidase enzyme (r=0.944). Xu *et al*. (2008) stated that flavonoids are the main part of phenolic compounds in citrus fruits, and according to the results of present experiment, this relationship is established between flavonoids and phenols.

Conclusion*:* Although blood orange is a valuable fruit, but, the highest amount of vitamin C and peroxidase was related to kumquat and the highest antioxidant capacity was obtained from grapefruit.

Keywords: *Anthocyanin, Antioxidant, Blood orange, Kumquat, Vitamin C.*

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