Differences in Antioxidant Properties among Cultivated Sugar Apples (Annona spp.)

Abstract

Antioxidant contents and their properties in ripened sugar apple (Annona squamosa L.) fruit cvs. Fai-kruang, Nang-kruang and Pet-Pakchong (A. cherimola, A. squamosa) were studied. Mature green fruits of these cultivars were harvested and left at ambient temperature until ripening (rind became soft). Then, those ripened fruits were investigated for antioxidant contents and theirs properties. It was found that ascorbic acid content from three ripened cultivars were slightly different (about 0.013-0.017 mg/g-FW) while phenolics and flavonoids in Fai-kruang and Nang-kruang were obviously higher than Pet-Pakchong about 3-4 times. Proanthocyanin in Nang-kruang (0.17 mg/g-FW) was clearly higher than Fai-kruang (0.02 mg/g-FW) and Pet-Pakchong (0.11 mg/g-FW). In case of reducing power (from Fe(II) to Fe(III)), there was comparable ability found in all 3 ripened cultivars (about 0.259-0.281 Abs. at 700 nm). On the contrary, the abilities of ferrous ion chelating and DPPH free radical scavenging were different among cultivars which were 74.14, 43.10 and 51.72% (ferrous ion chelating) and 16.81, 86.73 and 66.37% (DPPH free radical scavenging) in Fai-kruang, Nang-kruang, and Pet-Pakchong, respectively.

Keywords: antioxidant, ascorbic acid, phenolics, sugar apple

Introduction

Sugar apple (Annona squamosa L.) is widely cultivated in the tropical area. Its origin was considered to be Latin America and introduced later to other tropical areas. Sugar apple has high potential for commercially large-scale production in Thailand and Latin America.

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cultivation in Thailand. Among many cultivated Annona, A. squamosa is the most popular species (Palma et al., 1993) which can be categorized into two groups depend on the ripening character: (1) ‘Fai’, considering as fruit segments (carpels) are easily separated or spitted from each other during ripening and (2) ‘Nang’, during ripening the fruit segments are still connect to each other even though pulp firmness became soft and fruit rind can easily remove from pulp. Sugar apple cultivars in Thailand can be recognized by fruit peel color: cv. Fai (green); cv. Fai-kraung (raddish purple); cv. Nang (green) and cv. Nang-kraung (raddish purple). Besides, plant breeders from Pakchong Research Station bred the new and outstanding sugar apple cultivar, Pet-Pakchong, which has an oxheart shaped fruit, green rind and non-splitting carpels during ripening.

Sugar apple fruit growth and development period took about 90 days from flowering. Mature-green stage could be considered when the impressed lines around fruit segments are white to cream while at the harvesting time areoles become swollen, the impressed lines turned to creamy yellow and the individual carpels spread far apart. Normally, the harvested fruit rapidly ripen within 2-3 days at ambient room. The ripe fruit contain principle carbohydrate as a variety of simple sugars such as saccharose, glucose and fructose that impart the sweet taste (Andrade et al., 2001). The pulp is also regarded as good source of nutrition, vitamin and antioxidant substances for human health. Mono-terpenes and sesquiterpenes were identified as main volatile constituents in oil of sugar apple, some of which were α-pinene, sabinene, limonene, and (E)β-ocimene (Wong and Khoo, 1993; Andrade et al., 2001). Antioxidant components in certain fruits and vegetables have an effective ability to boost the human health. Nevertheless, there was still rare publication on antioxidant contents and their properties in sugar apple. Thus, the aim of this research was to investigate antioxidants among sugar apple cultivated in Thailand.

Materials and Methods

Mature-green sugar apple fruits cvs. Fai-kraung, Nang-kraung and Pet-Pakchong (average weight 250-300 g) were obtained from Pakchong Research Station, Nakhon Ratchasima, Thailand (Figure 1). The uniform fruits including a sack of CaC₂ (10 g/kg of fruit weight) were placed in the plastic basket that lined with two layers of newspaper sheets and then CaC₂ sack was removed from the basket within 24 hr. The experiment carries on in ambient room condition (30-35°C; 60-68% RH). The ripened fruits (pulp slightly soft) were investigated for antioxidant compounds: ascorbic acid (Klein et al., 1982); phenolics (Singleton and Rossi Jr., 1965); proanthocyanin (Li et al., 2006); flavonoids (Velavan et al., 2001) and antioxidant activity abilities such as reducing power, ferrous ion chelating and free radical scavenging (Chang et al., 2006).

Results and Discussion

CaC₂ is widely known as ethylene antagonistic substance that stimulates the ripening process of climacteric or senescing process in non-climacteric fruits (Sherma, 1985). The CaC₂ treated sugar apple fruits cvs. Fai-kraung, Nang-kraung and Pet-Pakchong completely ripened (pulp slightly soft) within 2 days and it turned to overripe stage in the next few days at ambient room temperature. During fruit ripening, starch content decreased while sugars increased (data not shown). Generally the overripe stage sugar apple is sweeter than ripe stage. Broughton and Guat (1979) found that starch content decreasing and sucrose increasing until reach the climacteric peak of respiration period while glucose and fructose were accumulated until the overripe stage. Further investigations of the enzyme mechanism involving in sugar metabolism of Thai A. squamosa fruits are carrying out in our laboratory to find the reason why overripe stage sugar apple is still acceptable for consumer than other overripe tropical fruits.

For antioxidant substances examination, sugar apple cvs. Fai-kraung, Nang-kraung and Pet-Pakchong contained moderate amount of ascorbic acid (0.0135; 0.0156 and 0.0174 mg/g-FW, respectively) (Figure 2a) comparing with some tropical fruits (Achinewhu, 1983). Typically in several climacteric fruits, ascorbic acid
content increased during ripening and slightly declined after the respiration rate reach the climacteric peak (Palma et al., 1993). This occurred because ascorbic acid is the useful substrate to solve stress mechanism in senescing process (Arnao et al., 1996). Phenolics content in ripened Fai-kruang (5.96 mg Gallic acid/g-FW) and Nang-kruang (6.96 mg Gallic acid/g-FW) fruits were significantly higher than that hybrid variety Pet-Pakchong (1.68 mg Gallic acid/g-FW) (Figure 2b). Flavonoid content also had the same tendency as those of phenolics: 0.615, 0.811 and 0.229 mg Rutine/g-FW in Fai-kruang, Nang-kruang and Pet-Pakchong, respectively (Figure 2c). Generally, phenolic compounds contribute largely to the color and sensory characteristics in fruits and vegetables. Phenolics and flavonoids are secondary metabolite products which have the beneficial properties for human health. The advantageous effects of these molecules are related to their antioxidant activity such as their ability to scavenge free radicals, donate hydrogen atoms or electrons and chelate metal cations (Heim et al., 2002). It is quite interesting that Nang-kruang and its hybrid variety had high amount of proanthocyanin (Figure 2d). In addition, proanthocyanin content in ripened Nang-kruang (0.170 mg Catechin/g-FW) and Pet-Pakchong (0.108 mg Catechin/g-FW) were obviously higher than Fai-kruang (0.020 mg Catechin/g-FW). According to anti-radical tests, it was revealed that Nang-kruang and Pet-Pakchong exhibited a strong radical-scavenging (DPPH) activity higher than Fai-kruang 4 and 3 times, respectively (Figure 3a). In case of cell protection against the harmful action of reactive oxygen species (ROS, oxygen free radicals), the reducing power ability of ripened Fai-kruang, Nang-kruang and Pet-Pakchong was about 0.2 at Absorbent 700 nm (Figure 3b). This ability may depend on the balance between the production and scavenging of ROS. Ferrous ion chelating ability of ripened Fai-kruang was higher than those of Pet-Pakchong and Nang-kruang at 74.14, 51.73 and 43.10%, respectively (Figure 3c). High concentrations of antioxidants showed considerable resistance to the oxidative damage caused by the ROS which effected to lipid peroxidation of plant membrane. However, the present research illustrated that DPPH radical-scavenging activities had a good correlation with the level of phenolics, flavonoid and proanthocyanin in ripened Nang-kruang fruit.

Figure 1 Typical fruit characteristic among 3 cultivars depending on peel color and carpel spitting: Fai-kruang (a), Nang-kruang (b) and Pet-Pakchong (c).
Summary

There was considerable variation in antioxidant contents and their properties among the sugar apple fruits cvs. Fai-kruang, Nang-kruang and Pet-Pakchong. The phenolics, flavonoid and proanthocyanin substances in cv. Nang-kruang were found relating to the DPPH free radical scavenging ability.

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