Antioxidant and stability of dragon fruit peel colour

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INTRODUCTION

Dragon fruit (Hylocereus polyrhizus) or Pitaya is emerging in health promotion product in addition to its known application in food having nutritional and decorative effects. In the genus Hylocereus, the fruit pulp has a variety of colour, which is white, red, and purple, including red and yellow peel. The red hue prepared from Hylocereus sp. fruit is being particularly requested in the market because of its health benefits and colour. Dragon fruit is gaining much attention recently because of its micronutrient enrichment regulated by the phenolics that possess antioxidant and antiproliferative activities in addition to its attractive colour. The pulp is popularly consumed in fresh fruit, and the juice is an additive to ice-cream colouring application. It exhibits anti-inflammatory and anti-diabetic properties with a suppression effect on cardiovascular disease including cancer prevention potential. Dragon fruit juice is therefore industrially manufactured as a functional drink to serve the consumers’ requirement of a natural supplement promoting good health condition. The fruit is considered as a functional food and therefore accounted as a food product with high economic value. Safely concern against synthetic colour has been increased, leading to a high demand for natural colour. An ecological product is particularly required by consumers, as well as the application of such raw material into green cosmetics. To prepare the red colour, which is beneficial for health care and used in food and cosmetic products, from the dragon fruit, stability of colour is needed to be clarified in order to vary the practical application of this natural colour in an industry.

Although there were some studies on the colour patterns of the red dragon fruit, the colour was from the pulp, which is the edible part of the fruit that alters food security. Therefore, sustainable application of the nonedible part or fruit residue would conserve the ecological consideration. Furthermore, preparation of colour from the fruit peel has rarely been introduced. Also, antioxidant activity, total phenolic and flavonoid contents, and characterization of phenolics in the peel have never been reported. In addition, the stability evaluation of the prepared colour has never been addressed. Thus, the natural colour prepared from the dragon fruit peel is worthy to be extracted using a practical and feasible method. Antioxidant activity by means of ABTS, DPPH, and FRAP assessments was evaluated with an analysis of polyphenols to reveal the other function of the colour. Biological activity and stability of the prepared colour will enable an economic and sustainable utilization of this agricultural product with the limitation of waste discarded. In addition, high profit of the food industry will be attained.

MATERIALS AND METHODS

Sample collection

Dragon fruit (H. polyrhizus), cultivated in Chiang Rai, Thailand, was collected. The fruit was washed with tap water and wiped to dry. The fresh peel was separated from the ripe fruit before cutting into small pieces (2 mm). The sample was further dried at 50°C in a hot air oven and ground into powder.

Colour extraction

The powdered peel was extracted in several conditions in search of the most suitable one. The powder was separately macerated with n-Hexane, EtOH, and deionized water (DI H2O) at various proportions of the sample and solvent, which are 1:10, 1:50, and 1:100. Each maceration was performed for three different durations, 10, 30, and 60 min, and concentrated to dryness in vacuo at 40°C. The extractive yield of each condition was compared.

ABTS radical scavenging activity

The ability of the extracts to scaveng 2,2’-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) radicals or ABTS** was determined. The stock solution containing 7 mM of ABTS (Fluka, USA) and 2.450 mM potassium persulfate (Fluka, USA) was incubated under ambient temperature for 16 h in a light protection vessel. Before use, the solution was diluted in EIOH (Merck, Germany) to obtain an absorbance of 0.700 ± 0.200 at 750 nm with a microplate reader (ASYS, UVM340, UK). The samples were mixed with the ABTS solution for 5 min prior to absorbance measurement at 750 nm. The concentration resulting in 50% inhibition (IC50) of ABTS** was calculated. The IC50 of a reference compound, ascorbic acid (Fluka, IC50 was calculated.
RESULTS AND DISCUSSION

The colouring application of the dragon fruit comes from the betalain pigments, betacyanins and betaxanthins. Betacyanins include betanins, phyllocactins, and betanidins (6, 12). Betalains in the dragon fruit pulp and peel were reported to be similar (3). Therefore, colour preparation from the peel is theoretically possible for application. In addition, utilization of the nonedible part offering sustainable application of this agricultural product will meet the consumers’ preference on ecological trend. Moreover, higher profit will be feasible for the food industry by transforming the fruit waste into a value-added material. However, none of the peel colour stability has been reported. Different proportion of solvent and extraction time were used to search for an optimized colour extraction condition (7, 8). The sample and solvent ratio of 1:10 was adopted from the pigment recovered in the dragon fruit (4). The most attractive pink colour was obtained from water extraction. The highest yield was obtained at the greatest sample and solvent proportion and at the longest extraction time. Water was found to be the best solvent, followed by ethanol and n-Hexane, respectively (19.31, 2.01, and 0.30%). Antioxidant activity was therefore comparatively assessed in the first and second most preferred colour and yield. ABTS, DPPH, and FRAP assessments were performed in parallel to confirm radical scavenging activity based on a single electron transferring mechanism. The water colour extract was more active than the ethanol one (Table 1), as confirmed by ABTS, DPPH, and FRAP assays. Although its activity was less than that of the positive controls, application of this natural antioxidant is acceptable. The active principle was further measured using the total phenolic content. The better antioxidant activity was consistency with the active content, that is, the water had more phenolics than the ethanol. This finding was in agreement with the previous report claiming dragon fruit peel as a promising source of antioxidant phenolics (2). Thus, the highly preferred pink colour prepared from water was more economically feasible with a better biological activity.

Although betalains in dragon fruit are informatively studied, biologically active phenolics are rarely presented except gallic acid and caffeic acid in dragon fruit seed (13). In addition to caffeic acid and gallic acid, ferulic acid, gallic acid, kojic acid, rosmarinic acid, chlorogenic acid, and quercetin that are widely distributed in plants and known as antioxidants sharing the shikimic biosynthesis pathway were analyzed. This present finding of gallic acid, chlorogenic acid, and quercetin (Table 2) were therefore reported in dragon fruit peel for the first time. However, the content of these phenolics were higher in ethanol extract, which poses a less attractive colour. The preferred red-purple colour of water extract with better antioxidant may be regulated by betalains. Nevertheless, the dragon fruit peel would be applicable as a potential natural source of chlorogenic acid, quercetin, and gallic acid.

Dragon fruit peel water extract, having more attractive colour with better antioxidant activity, was therefore chosen for colour stability evaluation. The colour with a different concentration would be applicable as a potential natural source of antioxidative activity and yield. ABTS, DPPH, and FRAP assessments were performed in parallel to confirm radical scavenging activity based on a single electron transferring mechanism. The water colour extract was more active than the ethanol one (Table 1), as confirmed by ABTS, DPPH, and FRAP assays. Although its activity was less than that of the positive controls, application of this natural antioxidant is acceptable. The active principle was further measured using the total phenolic content. The better antioxidant activity was consistency with the active content, that is, the water had more phenolics than the ethanol. This finding was in agreement with the previous report claiming dragon fruit peel as a promising source of antioxidant phenolics (2). Thus, the highly preferred pink colour prepared from water was more economically feasible with a better biological activity. Although betalains in dragon fruit are informatively studied, biologically active phenolics are rarely presented except gallic acid and caffeic acid in dragon fruit seed (13). In addition to caffeic acid and gallic acid, ferulic acid, gallic acid, kojic acid, rosmarinic acid, chlorogenic acid, and quercetin that are widely distributed in plants and known as antioxidants sharing the shikimic biosynthesis pathway were analyzed. This present finding of gallic acid, chlorogenic acid, and quercetin (Table 2) were therefore reported in dragon fruit peel for the first time. However, the content of these phenolics were higher in ethanol extract, which poses a less attractive colour. The preferred red-purple colour of water extract with better antioxidant may be regulated by betalains. Nevertheless, the dragon fruit peel would be applicable as a potential natural source of chlorogenic acid, quercetin, and gallic acid.

Dragon fruit peel water extract, having more attractive colour with better antioxidant activity, was therefore chosen for colour stability evaluation. The colour with a different concentration was prepared in a buffer solution at various pH conditions. A pH higher than 7 was included in this present study because some cosmetic products are prepared at the basic condition. Thus, wider pH stable range would offer several applications of this ecological colour. The effect of stored temperature was...
monitored at 23°C, 37°C, and 50°C [7,8]. The CIE system was applied in this research because L*, a*, and b* colour spaces are more convenient than the tristimulus values [11]. Lightness in terms of standard, moderate, and pale along a grey scale is recorded by L* ranging from white (100) to black (0). The colours green (-) and red (+) are shown by a* coordinate. The b* is the hue of blue (-) and yellow (+). Changing of colour is determined in terms of a colour difference (ΔE), where ΔE = [(ΔL*)2 + (Δa*)2 + (Δb*)2]1/2 [14]. Colour stability was therefore monitored by ΔE.

Those with less than 5 were focused because colour difference will be distinguished at ΔE = 5 (15). In relation to this postulate, the dragon fruit peel colour at all concentration and temperature in buffer pH 9 was stable (Table 3). In addition, the extract concentrated at 0.1 mg/mL remained stable following 50°C storage in buffer, pH 3 and 7, similar to the colour at 37°C and pH 5 that was not changed at the same concentration. This was consistent with the stability of betalains over pH 3–7 (16).

However, according to Stark [14] and Gonnell [17], changing of colour is perceivable by the human eye at ΔE of 1.5 and 1, respectively. Therefore, the most stable condition of the dragon fruit peel colour would be in buffer pH 9 stored at 30°C and concentrated at 0.4 mg/mL with the minimum ΔE of 0.09, followed by 1.0 mg/mL (ΔE = 0.13). At this buffer condition, 37°C and 23°C maintained the colour quality at 0.4 mg/mL (ΔE = 0.12) and 1.0 mg/mL (ΔE = 0.63), respectively. In terms of changing the colour that is regulated by three coordinate parameters (L*, a*, and b*), minimal shift of these values will minimize ΔE. These parameters were subjectively evaluated. ΔL* was rarely changed at pH 9 especially at 50°C, followed by 37°C and 23°C. Red and purple betalains of dragon fruit colour are mainly from betacyanins, which are 3,4-dihydroxy bases on acyl migration effect. The migration is pH dependent bases. The molecules (3), they should be more stable in alkaline media under acidic conditions, resulting in unstable betalains (12). Greater stability of betacyanins at higher pH condition is different from betaxanthins that impart the yellow-orange shade of the dragon fruit. Moreover, increasing of betacyanin ratios was exhibited by a reduction of L* (18). This parameter was decreased in all condition but least changed in buffer pH 9, conferring higher betacyanins exhibiting the red shade and confirming colour stability of the dragon fruit peel consequently. In addition, the red shade (a*) that hardly shifted (Table 3) was prepared in red-purple colour stability. Stability of colour at the best storage condition was further examined.

Parameters relevant to betacyanins were analyzed. Colour differences were all less than 1 all throughout the examination period (Table 4), similar to L* and a*. Interestingly, red-purple colour was stable at high temperature (50°C). High temperature largely degraded the yellow pigments, betaxanthins, as betacyanins were reported stable after heating at 85°C for 1 h (19).

CONCLUSION

Dragon fruit peel is a potential source of red-purple colour for food and cosmetic decorations. Its ecological origin is meeting an economical perspective and the consumers’ preference for green products as well. In addition, the moderate antioxidant activity based on phenolics indicates multifunction of this fruit waste application. Furthermore, dragon fruit peel is applicable as an alternative source of natural chlorogenic acid, quercetin, and gallic acid for other health-care application.

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