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Original Research Article

Bioactive Compounds and Antioxidant Activities of Different Varieties of Cherry Tomato Extracts

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ABSTRACT

Cherry tomato (CT; *Solanum lycopersicum* var. *cerasiforme*) is well known as a rich source of nutrition. Six different varieties (as represented in different colors; red, yellow, chocolate, black, gold, and white color) of CT with four different solvents extraction including deionized water (DI), ethanol, acetone, and ethyl acetate were investigated on the scope bioactive compounds (total phenolic (TPC), flavonoid (TFC), carotenoid, lycopene and anthocyanin (TAC)) contents and antioxidant properties (DPPH and FRAP activities). The results showed that all DI extracts of CT had higher TPC. Yellow CT had significantly the highest TPC. Besides, ethanol extracts of CT had higher TFC. Red and yellow CT showed significantly the highest TFC (p<0.05). Carotenoid and lycopene content were higher in low polarity solvents that ethyl acetate extract of gold and chocolate CT had significantly the highest content. TAC study showed that ethanol extracts of CT had higher content, of which, ethanol extract of black CT had the highest TAC. In the antioxidant study, DI extracts of all varieties of CT had higher antioxidant activities. Especially, DI extract of yellow and gold CT had significantly the highest antioxidant in DPPH and FRAP. Evaluating the correlation between bioactive compounds and antioxidant activities, a positive correlation was observed between TPC and DPPH scavenging activity. Carotenoid and lycopene also correlate with DPPH scavenging activity. All varieties of CT (especially yellow CT) showed high bioactive compounds which significantly possess antioxidant activity. CT has the potential used as health-promoting food and bioactive ingredient in cosmetics and other related products.

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INTRODUCTION

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*), a member of Solanaceae family, is among the most widely consumed crops worldwide due to its sweeter taste and has high nutrition such as ascorbic acid, vitamin A, vitamin E, potassium, and folate which are present in both raw and cooked. Cherry tomato has smaller in size than other tomatoes, generally round in shape and weighing 10 to 30 grams (Bhandari *et al*. 2016). Besides, the cherry tomato has health benefits commonly associated with reduced risk of cardiovascular disease and degenerative disease including anticancer, anti-platelet, and anti-oxidant. These health benefits are due to the presence of bioactive compounds in tomatoes such as carotenoids (β-carotene and lycopene), vitamins (ascorbic acid and tocopherols), phenolic compounds including hydrocinnamic acids (mainly caffeic acid and its ester chlorogenic acid) and flavonoids such as narigenin, rutin and glycoalkaloid (tomatine). Carotenoids, β carotene, and lycopene are responsible for the color pigment in many plants and vegetables and are also a rich source in tomatoes (Bhandari *et al*., 2016; Chaudhary *et al*., 2018; Shahzad *et al*., 2014). In addition, carotenoid contributes to yellow and orange pigment color, while Lycopene contributed a red color carotenoid. Both carotenoid and lycopene have antioxidant ability for preventing oxidative stress that may help prevent cancer, cardiovascular disease diabetes, and other diseases (Eggersdorfer & Wyss, 2018).

Currently, there are a large number of cherry tomato varieties, as represented in different colors, such as Red cherry tomato, Yellow cherry tomato, Chocolate cherry tomato, Black cherry tomato, Gold cherry tomato, and White cherry tomato, etc. A previous study showed that purple or black cherry tomatoes had higher antioxidant ability than red cherry tomatoes (Campestrini *et al*., 2019). However, there are a few studies comparing bioactive compounds and antioxidant activities between cherry tomato varieties. Thus, this study aimed to compare bioactive compounds and antioxidant activities in different varieties of cherry tomatoes for further use as heath benefit food or used as an active ingredient in cosmetics or related products.

MATERIALS AND METHODS

Chemicals and reagents

All chemicals and solvents were analytical grades. Cosmetic ingredients were cosmetic grade. ABTS (2,2' - azino- bis(3-ethylbenzthiazoline- 6- sulfonic acid)) , aluminum chloride (AlCl3) , catechin, dibasic phosphate, dimethylsulfoxide (DMSO) , 2,2- diphenyl-1-picrylhydrazyl (DPPH), 95% ethanol, ferric chloride, folin-ciocalteu, gallic acid, glydent DMDM hydantoin, hydrochloric acid (37%) , methanol, menthol, monobasic phosphate, potassium acetate (CH3COOK), potassium persulphate (K2S2O8), propylene glycol (PG), quercetin, sodium carbonate (Na2CO3) , sulfuric acid, vanillin, 2,4,6-tris(2-pyridyl)-1,3,5-triazin (TPTZ), trolox, sodium metabisulfite.

Collection of samples

Cherry tomato seeds were cultivated in a greenhouse at Tae Kob Fah farm located in Suphan Buri province. Six varieties of Cherry tomato, including Red cherry tomato (RC) , Yellow cherry tomato (YC) , Chocolate cherry tomato (CC) , Black cherry tomato (BC) , Gold cherry tomato (GC), and White cherry tomato (WC), were cultivated in closed system technique that controls lights, water, and temperature. After 3 months, all six varieties of Cherry tomatoes were collected, cleaned, finely sliced and dried.

Extraction of bioactive compounds

Six varieties of dried cherry tomatoes were weighed 24 g and then macerated with 300 mL of deionized water (DI), 95% ethanol, acetone, or ethyl acetate for 24 h at room temperature. Then, all extractions except DI extraction were filtered and evaporated with a rotary evaporator. DI extraction was dried with a freeze-dryer. All extracts were kept in the dark at -4 ºC until used. The yield of extracts was calculated as the percentage of dry basis (%yield).

Determination of bioactive compounds

Total phenolic content (TPC)

TPC was measured by colorimetric method with slightly modification (Dorkbuakaew *et al*., 2016; Thitipramote *et al*., 2016; 2022). Briefly, 60 µL of cherry tomato extracts were reacted with 300 µL of 0.2 M Folin-Ciocalteu reagent for 1 min at RT and then added 240 µL of 7.5% Na2CO3. The mixture was kept in the dark for 30 min at RT and then the absorbance was measured at 765 nm using a microplate reader (Biotek, Epoch, USA). Gallic acid was used as a reference standard, and the results were expressed as mg gallic acid equivalents (GAE)/100 g.

Total flavonoid content (TFC)

TFC was measured by the colorimetric method according to Thitiptamote *et al*. (2016; 2022) with slight modification. Briefly, 400 µL of cherry tomato extracts were mixed with 20 µL of 10% (w/v) $AlCl_3$, 20 µL of 1M CH_3 COOK, and 560 µL of DI water, respectively. The mixture was kept in the dark for 30 min at RT and then the absorbance was measured at 415 nm using a microplate reader. Quercetin was used as a reference standard and the results were expressed as mg quercetin equivalents (QE)/100 g.

Total carotenoid content and lycopene

Total carotenoid and lycopene were measured according to Lee (2001) and Fish *et al*. (2002). Briefly, CT extracts at a concentration of 1 mL were mixed with 5 mL of reagents containing 25% ethanol, 50% hexane, 25% acetone, and 0.05% BHT. The mixture was kept in RT for 30 min. Then, the supernatant of the mixture was removed and brought to measure at wavelengths of 450 and 503 nm, respectively.

Determination of DPPH radical scavenging activity (DPPH assay)

The DPPH radical scavenging activity was performed as previously described (Thitipramote *et al*., 2016; 2022). Briefly, 400 µL of cherry tomato extracts were mixed with 7.6 mL of DPPH reagent. The reaction mixture was kept in the dark for 30 min at RT and then the absorbance was measured at 515 nm using a microplate reader. Trolox solution was used as a reference standard. The percentage (%) of inhibition was calculated by following the formula and the results were expressed as mg Trolox equivalent antioxidant capacity (TEAC)/g extract.

% inhibition = (A control - A extract) /(A control) × 100

Where, A control = the absorbance of the control;

A extract = the absorbance of sample.

Determination of ferric reducing antioxidant power activity (FRAP assay)

Reducing power was measured as previously described (Thitipramote *et al*., 2016; 2022). Briefly, FRAP solution was freshly prepared by mixing 10 ml of TPTZ solution in 40 mM hydrochloric acid with 10 ml of 20 mM ferric chloride and 100 ml of 0.3 M acetate buffer (pH 3.6). For analysis, 30 µL of cherry tomato extracts were mixed with 570 mL of FRAP solution. The mixture was kept in the dark for 15 min at RT and then the absorbance was measured at 593 nm using a microplate reader. Trolox was used as a reference standard, and the results were expressed as mg Trolox equivalent antioxidant capacity (TEAC)/100g.

Statistical analysis

All data measurements were done in triplicate and expressed as mean ± standard deviation. Data were analyzed by using one-way ANOVA. Pearson correlation test was used to assess correlation between

antioxidant capacity and total phenolic and total flavonoid contents. A significant difference is considered at the level of $p < 0.05$.

RESULTS AND DISCUSSION

Extraction yield of cherry tomatoes

Six varieties of Cherry tomato (RC), including Red cherry tomato (RC), Yellow cherry tomato (YC), Chocolate cherry tomato (CC), Black cherry tomato (BC), Gold cherry tomato (GC), and white cherry tomato (WC) was extracted with deionized water (DI), 95% ethanol, acetone or ethyl acetate for 24 h at room temperature. The yield of extract was calculated as a dry basis (%yield). Results showed that the extraction yields of each variety of cherry tomatoes and each solvent from each extract were different as shown in Table 1.

Comparing solvent extraction, the ethanol extract statistically exhibited a higher extraction yield than other solvents (p<0.05). Comparing varieties of CT, yellow, red, and chocolate exhibited higher extraction yields (32.68, 26.83, and 26.59 %yield, respectively).

Determination of bioactive compounds of cherry tomatoes

Bioactive compounds (total phenolic, flavonoid, carotenoid, and lycopene content) of many plants including cherry tomatoes have different polarities and thus require different polarities of solvents for extraction. This study used four different solvents; ethanol and DI (high-polarity solvents) and ethyl acetate and acetone (low-polarity solvents) for extractions. The results showed that six varieties of CT with four different solvents had significant differences (p<0.05). In the study of total phenolic content (TPC), results demonstrated that DI extraction of all varieties of CT had statistically higher TPC than other solvents (ranging between 17.22 to 29.77 mg GAE/100 g) as shown in Table 2. Comparing varieties CT in the same solvent, yellow, black, and chocolate CT showed statistically higher TPC than other varieties (29.77±0.98, 29.51±0.41 and 29.34±1.09 mg GAE/100 g, p<0.05, respective). According to Hemathulin & Techawongstien (2016) study, Red CT and Yellow CT had significantly higher TPC (27.63 and 24.98 mg GAE/ 100 g, respectively).

The total flavonoid content (TFC) in six varieties of CT was shown in Table 2. The results demonstrated that the ethanol extract of all six varies of CT exhibited higher TFC than other solvents (ranging between 10.90 to 26.48 mg QE/100 g). The results also found that red, yellow, and black had higher TFC than other varieties of CT when comparing varieties CT in the same solvent (26.48±2.89, 23.98±1.58 and 23.35±1.54 mg QE/100 g, p<0.05, respectively). According to a previous study, tomatoes mostly had statistically significant TFC ranging from 4 to 26 mg/ 100 g (p<0.05) (Rune *et al*., 2008). However, CT cultivated in Korea showed higher TFC varied from 86 to 124 mg/100 g. These might be due to genotype differences, agricultural practices, and environmental conditions (Bhandari *et al*., 2016).

Carotenoids, β-carotene, and lycopene are the main pigment found in cherry tomatoes. Carotenoid is a pigment of yellow, orange, red, and orange-red. These pigments are present in different varieties of CT. Carotenoids are classified as fat-soluble micronutrients and are mostly soluble in low-polarity solvents. The results showed that low polarity, especially in acetone and ethyl acetate (ranging between 14.58 to 19.50 mg/ 100g), tended to have higher carotenoids than high polarity solvents as shown in Table 3. Comparing varieties of CT, red, chocolate and black CT had statistically higher carotenoid content than other varieties of CT (19.68, 19.65, and 19.28 mg/100 g). This study showed that CT had statistically significantly higher carotenoid content than regular tomatoes ranging between 5.7 to 9.57 mg/100 g (Motsapha *et al*., 2014).

Lycopene, a red-colored carotenoid, was found in the peel and pulp of cherry tomatoes. The results also showed that low polarity, especially in acetone and ethyl acetate (ranging between 7.06 to 0.83 mg/ 100g), tended to have higher lycopene than high polarity solvent as shown in Table 3. Lycopene content in this study had lower content than Ahmad *et al*. (10.52 mg/100 g in acetone-petroleum ether extraction) and Luciano *et al*. (11.17 mg/100 g in acetone-hexane extraction). A previous study showed that black CT, blackish-red skin, had higher lycopene content (Ha *et al*., 2021). However, this study showed that red CT had statistically the highest lycopene in all solvents (p<0.05). These might be due to differences in solvent extraction and cultivars.

Table 1 Extraction yield of six varieties of cherry tomato (red, yellow, chocolate, black, gold, and white) with four different solvents (DI water, ethanol, acetone, and ethyl acetate)

Cherry tomato (CT)	Yield of extracts (%)			
	DI water	Ethanol	Acetone	Ethyl Acetate
Red	7.02±0.01^{Db}	26.83±0.01^{Ba}	1.80±0.01^{Dc}	0.49±0.01^{Fd}
Yellow	5.58±0.01^{Fb}	32.68±0.01^{Aa}	2.16±0.01^{Cc}	0.42±0.01^{Ed}
Chocolate	6.57±0.01^{Eb}	26.59±0.01^{Ca}	2.22±0.01^{Bc}	1.29±0.01^{Bd}
Black	8.18±0.01^{Cb}	19.65±0.01^{Ea}	2.50±0.01^{Ac}	2.02±0.01^{Ad}
Gold	11.11±0.01^{Bb}	14.52±0.01^{Fa}	1.72±0.01^{Ec}	0.62±0.01^{Cd}
White	13.86±0.01^{Ab}	24.16±0.01^{Da}	1.39±0.01^{Fc}	0.61±0.01^{Dd}

Note: All data are expressed as mean±standard deviation (SD). Difference in the uppercase superscribe letters (A, B, C) within the same column indicates statistically different value among varieties of samples. Difference in the lowercase superscribe letters (a, b, c) within the same row indicates statistically different value among solvents (ANOVA, Tukey's test; p<0.05).

Table 2 Total phenolic content (TPC) and total flavonoid content (TFC) of six varieties of cherry tomato (red, yellow, chocolate, black, gold, and white) with four different solvents (DI water, Ethanol, acetone, and ethyl acetate)

Cherry tomato (CT)	Total phenolic content (mg GAE/ 100 g)				Total flavonoid content (mg QE/ 100 g)			
	DI water	Ethanol	Acetone	Ethyl acetate	DI water	Ethanol	Acetone	Ethyl acetate
Red	25.77±0.98^{Ba}	9.86±0.54^{Db}	8.20±0.85^{Bc}	7.56±0.72^{Ac}	18.67±2.97^{A}	26.48±2.89^{A}	18.15±3.28^{AB}	18.44±2.95^{AB}
Yellow	29.77±0.92^{Aa}	20.83±0.89^{Ac}	23.23±0.73^{Ab}	7.66±1.04^{Ad}	10.20±0.41^{C}	23.98±1.58^{AB}	16.55±0.96^{B}	14.00±2.43^{B}
Chocolate	29.34±1.09^{Aa}	7.73±0.35^{Eb}	8.01±0.79^{Bb}	6.32±1.37^{Ab}	18.92±0.53^{A}	22.05±2.34^{B}	20.39±1.58^{A}	19.50±1.96^{A}
Black	29.51±0.41^{Aa}	13.38±0.92^{Cb}	6.55±0.96^{Bc}	7.40±1.15^{Ac}	13.48±0.28^{B}	23.35±1.54^{AB}	18.04±1.85^{AB}	15.05±2.04^{AB}
Gold	17.22±0.45^{Da}	7.78±1.28^{Eb}	6.54±0.81^{Bb}	6.60±0.93^{Ab}	12.01±0.21^{B}	20.40±0.84^{B}	16.04±1.65^{B}	16.34±3.13^{AB}
White	20.30±0.37^{Ca}	18.03±1.71^{Ba}	8.29±1.31^{Bb}	5.92±1.58^{Ab}	9.83±0.23^{C}	10.90±0.21^{C}	10.34±0.65^{C}	8.92±2.07^{C}

Note: All data are expressed as mean±standard deviation (SD). Difference in the uppercase superscribe letters (A, B, C) within the same column indicates statistically different value among varieties of samples, and Difference in the lowercase superscribe letters (a, b, c) within the same row indicates statistically different value among solvents (ANOVA, Tukey's test; p<0.05).

Table 3 Total carotenoid content and total lycopene content of six varieties of cherry tomato (red, yellow, chocolate, black, gold, and white) with four different solvents (DI water, Ethanol, acetone, and ethyl acetate).

Cherry tomato (CT)	Total carotenoid content (mg/ 100 g)				Total lycopene content (mg/ 100 g)			
	DI water	Ethanol	Acetone	Ethyl acetate	DI water	Ethanol	Acetone	Ethyl acetate
Red	1.29±0.01^{Ad}	11.76±0.02^{Ac}	14.58±0.01^{Aa}	13.43±0.01^{Cb}	0.73±0.01^{Ad}	2.53±0.01^{Ac}	5.34±0.01^{Aa}	4.62±0.01^{Cb}
Yellow	0.41±0.01^{Dd}	3.15±0.01^{Da}	2.52±0.01^{Fc}	2.96±0.01^{Fb}	0.16±0.01^{Dd}	0.41±0.01^{Ec}	0.45±0.01^{Fb}	0.94±0.01^{Ea}
Chocolate	0.47±0.02^{Cd}	5.73±0.01^{Bc}	11.55±0.01^{Bb}	19.35±0.04^{Ba}	0.22±0.01^{Cd}	0.97±0.01^{Cc}	3.16±0.01^{Bb}	7.15±0.01^{Aa}
Black	0.52±0.01^{Bd}	11.77±0.01^{Aa}	9.63±0.02^{Cc}	10.55±0.01^{Db}	0.22±0.01^{Cd}	1.94±0.01^{Bc}	3.12±0.01^{Cb}	2.98±0.01^{Da}
Gold	0.33±0.01^{Ed}	4.90±0.01^{Cc}	7.50±0.01^{Db}	19.65±0.07^{Aa}	0.33±0.01^{Bd}	0.64±0.01^{Dc}	0.95±0.01^{Db}	7.06±0.01^{Ba}
White	0.21±0.02^{Fd}	1.40±0.01^{Ec}	3.77±0.01^{Eb}	5.06±0.01^{Ea}	0.15±0.01^{Dd}	0.33±0.01^{Fc}	0.62±0.01^{Eb}	0.83±0.01^{Fa}

Note: All data are expressed as mean±standard deviation (SD). Difference in the uppercase superscribe letters (A, B, C) within the same column indicates statistically different value among varieties of samples and Difference in the lowercase superscribe letters (a, b, c) within the same row indicates statistically different value among solvents (ANOVA, Tukey's test; $p<0.05$).

Determination of antioxidants in cherry tomatoes

Antioxidants known as free radical scavengers help prevent the development of chronic and degenerative illnesses, such as cancer, aging, cardiovascular, and neurodegenerative diseases, caused by oxidative stress. The roles of antioxidants are to neutralize the excess of free radicals to protect the cells through several mechanisms such as hydrogen donor, radical scavenging, redox reaction, etc.

Different colors of CT showed different bioactive compounds and might affect antioxidant activities. The antioxidant activities of six varieties of extract of CT were determined using DPPH radical scavenging activities and ferric reducing antioxidant power (FRAP assay) as shown in Table 4.

DPPH assay was based on the ability of a compound that can donate a hydrogen atom from 2,2'-diphenyl-1-picrylhydrazyl converted into 2,2'-diphenyl-1-picrylhydrazine. (Pyrzynska and Pękal, 2013). The results showed that DI extract of all varieties of CT significantly exhibited higher antioxidant activity (ranging between 3.83 to 4.85 mg TEAC/100 g) than other solvents. The highest was found in yellow CT (4.85±0.08 mg TEAC/100 g, $p<0.05$) followed by chocolate, and gold CT (4.68±0.08 and 4.57±0.35 mg TEAC/g extract) ($p<0.05$).

Zanfini *et al*. (2017) demonstrated that yellow tomatoes cultivar contained lower carotenoids than red and black tomato cultivars but had higher antioxidant activities. This might be due to the yellow tomatoes cultivar containing rutin, one of the main polyphenolic compounds, higher than others. Furthermore, a previous study found that Red CT had significantly higher antioxidant activity than Yellow CT (7.36 and 5.47 mg Ascorbic acid/100 g, $p<0.05$) and white CT (Hemathulin *et al*., 2016; Kim *et al*., 2020), this might be due to different in cultivar area. While the mechanism of the FRAP assay is different from the DPPH assay, the FRAP assay is used to examine the antioxidant competency by the redox reaction of ferric ion ($Fe3^{+}$) to ferrous ($Fe2^{+}$) (Sharopov *et al*., 2015). The results showed that the DI extract of all varieties of CT significantly exhibited higher FRAP antioxidant activity (ranging between 5.25 to 8.36 mg TEAC/100 g) than other solvents. This might be due to the DI extracts of all varieties having higher TPC than other solvents. A previous study showed that TPC correlated with antioxidant activity (Prassana *et al*., 2020). Comparing between varieties of CT, the highest FRAP was also significantly exhibited in gold CT (8.36±0.35 mg TEAC/100 g, $p<0.05$), followed by black and white CT (7.55±0.57 and 6.71±0.77 mg TEAC/100 g, $p<0.05$). However, this study showed lower FRAP activity than the previous study ranging from 17.82 to 22.91 µmol/g dry weight (Bhandari *et al*., 2016).

Evaluating the correlation between bioactive compounds and antioxidant activities, the study found statistical differences in varieties of CT. Results showed a significant positive correlation between TPC and DPPH scavenging activity (R2 = 0.841, $p<0.05$) more than a positive correlation between the TPC and FRAP assay (R = 0.165, $p<0.05$). Moreover, the study showed a positive correlation between carotenoid, lycopene, and antioxidant, especially in the DPPH assay. Carotenoid and lycopene also correlate with DPPH scavenging activity (R2 = 0.752 and 0.616, $p<0.05$, respectively) but they had no correlation with FRAP assay.

Table 4 Antioxidant activities (DPPH and FRAP activities) of six varieties of cherry tomato (red, yellow, chocolate, black, gold, and white) with four different solvents (DI water, Ethanol, acetone, and ethyl acetate).

Cherry tomato (CT)	DPPH (mg TEAC/ 100 g)				FRAP (mg TEAC/ 100 g)			
	DI water	Ethanol	Acetone	Ethyl acetate	DI water	Ethanol	Acetone	Ethyl acetate
Red	3.90±0.58^{Ba}	3.28±0.04^{Db}	2.83±0.03^{Cc}	2.90±0.08^{Ac}	6.63±0.46^{BCa}	0.58±0.18^{Bb}	0.71±0.04^{Ac}	1.59±0.07^{Bb}
Yellow	4.85±0.08^{Aa}	3.58±0.01^{Bc}	4.41±0.07^{Ab}	3.11±0.05^{Ad}	5.25±0.22^{Da}	2.43±0.64^{Abc}	1.33±0.32^{Ac}	2.94. ±0.23^{Ab}
Chocolate	4.68±0.08^{Aa}	3.08±0.01^{Eb}	3.00±0.09^{BCb}	2.98±0.20^{Ab}	5.84±0.57^{CDa}	0.64±0.36^{Bc}	0.44±0.15^{Ac}	1.25±0.15^{BCb}
Black	3.83±0.10^{Ba}	3.28±0.01^{Db}	3.03±0.19^{BCb}	3.04±0.13^{Ab}	7.55±0.57^{ABa}	1.23±0.35^{Bb}	1.59±0.33^{Ab}	0.37±0.09^{Cb}
Gold	4.57±0.35^{Aa}	3.68±0.01^{Ab}	3.08±0.16^{Bc}	3.06±0.17^{Ac}	8.36±0.35^{Aa}	1.19±0.20^{Bc}	1.26±0.20^{Abc}	2.69±0.43^{Ab}
White	4.51±0.14^{Aa}	3.53±0.01^{Cb}	3.21±0.12^{Bc}	3.01±0.10^{Ad}	6.71±0.77^{BCa}	1.06±0.24^{Bc}	1.69±0.35^{Ab}	1.25±0.28^{BCc}

Note: All data are expressed as mean±standard deviation (SD). Difference in the uppercase superscribe letters (A, B, C) within the same column indicates statistically different value among varieties of samples, and Difference in the lowercase superscribe letters (a, b, c) within the same row indicates statistically different value among solvents (ANOVA, Tukey's test; $p<0.05$).

CONCLUSIONS

All varieties of cherry tomatoes showed high bioactive compounds. Especially yellow cherry tomatoes had higher total phenolic content and higher antioxidant activities using the DPPH assay. While red cherry tomatoes had higher total flavonoid content and lycopene, yellow, gold, chocolate, black, and white cherry tomato significantly possess antioxidant activity. Thus, cherry tomato varieties can be used as a rich source of bioactive compounds and have the potential used as health-promoting food and bioactive ingredient in cosmetics and other related products.

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