

Research Article

Antioxidant Capacities of Various Fruit Extracts from three Varieties of Tomato and Correlation with Total Phenolic, Flavonoid, Carotenoid Content

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ABSTRACT

The objectives of this research were to study antioxidant capacity of various fruit extracts from three varieties of tomato using two methods of antioxidant testing which were DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power) and correlation of total flavonoid, phenolic and carotenoid content in various fruit extracts of tomato with IC₅₀ of DPPH and EC₅₀ of FRAP antioxidant capacities. Extraction was performed by reflux using different polarity solvents. The extracts were evaporated using rotary evaporator. Antioxidant capacities using DPPH and FRAP assays, determination of total phenolic, flavonoid and carotenoid content were performed by spectrophotometry UV-visible and its correlation with IC₅₀ of DPPH scavenging capacities and EC₅₀ of FRAP capacities were analyzed by Pearson's method. Ethyl acetate fruit extract of larisa variety (LA2) had the lowest IC₅₀ of DPPH scavenging capacity (0.14 µg/ml) and the lowest EC₅₀ of FRAP capacity was given by ethyl acetate fruit extract of amala variety (AM2) 46.9 µg/ml. Ethyl acetate fruit extract of larisa variety (LA2) contained the highest total phenolic (6.27 g GAE/100 g), n-hexane fruit extract of larisa variety (LA1) had the highest flavonoid content (5.13 g QE/100 g) and the highest total carotenoid content 58.74 g BE/100 g. There were negatively and high correlation between total phenolic content in fruit extracts of amala and larisa varieties with their IC₅₀ of DPPH scavenging activities and EC₅₀ of FRAP capacities. All of fruit extracts from three varieties of tomato had linear result in DPPH and FRAP assays.

Keywords: Antioxidant, DPPH, FRAP, fruit, tomato, phenolic, flavonoid, carotenoid

INTRODUCTION

The risk of many diseases has related with oxidative stress which can be reduced by antioxidant. Phenolic compounds are commonly found in plants, and they have been reported to have many effects, including antibacterial, anti-inflammatory and antioxidant activity¹⁻³. Many studies⁴⁻⁶ reported that phenolic content and flavonoid content in plants could be correlated to their antioxidant activities. Plants including tomato contained phenolic and polyphenol compounds can act as antioxidant⁷⁻⁹. Some of antioxidant methods such as DPPH (2,2-diphenyl-1-picrylhydrazyl) and FRAP (Ferric Reducing Antioxidant Power) were used to predict antioxidant capacity of vegetables, fruits and food^{1,10,11}. The previous study^{1,3,12} exposed that DPPH, FRAP and ABTS assays could be used to determine antioxidant activity in many plants extracts. The objective of this research were to study antioxidant capacities of different polarities extracts (n-hexane, ethyl acetate and ethanol) of fruit from three varieties of tomato (amala, larisa and bunch) using antioxidant testing DPPH and FRAP assays and correlation of their antioxidant capacities with total phenolic, flavonoid and carotenoid content in each extract.

MATERIALS AND METHODS

Materials

TPTZ (2,4,6-tripyridyltriazine), DPPH (2,2-diphenyl-1-picrylhydrazyl), gallic acid, quercetin, beta carotene was purchased from Sigma-Aldrich (MO, USA), ferric chloride, fruits from three varieties of tomatoes, n-hexane, ethyl acetate, ethanol. All other reagents were analytical grades.

Preparation of sample

Fruits from three varieties of tomato (*Solanum lycopersicum*) were collected from Lembang-Bandung, West Java, that were: Amala variety namely as AM, Larisa variety as LA and Bunch variety as BU, were thoroughly washed with tap water, wet sortation, cut, dried and grinded into powder.

Extraction

Three hundred grams of powdered samples were extracted by reflux using increasing gradient polarity solvents. The n-hexane extract was repeated three times. The remaining residue was then extracted three times with ethyl acetate. Finally the remaining residue was extracted three times with ethanol. So there were three n-hexane extracts (namely AM1, LA1 and BU1), three

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ethyl acetate extracts (AM2, LA2 and BU2) and three ethanolic extracts (AM3, LA3 and BU3).

IC₅₀ of DPPH scavenging activity

Preparation of DPPH solution was adopted from Blois¹³ with minor modification. Various concentration of each extract were pipetted into DPPH solution 50 µg/ml (1:1) to initiate the reaction for obtaining a calibration curve. After 30 minutes incubation, the absorbance was read at wavelength 515 nm by using spectrophotometer UV-Vis Hewlett Packard 8435. Methanol was used as a blank. DPPH solution 50 µg/ml was used as control. Ascorbic acid was used as standard. Analysis was done in triplicate for standard and each extract. Antioxidant activity of each extract was determined based on the reduction of DPPH absorbance by calculating percentage of antioxidant activity¹⁴. IC₅₀ of DPPH scavenging activity of each extract can be calculated using its calibration curve.

EC₅₀ of FRAP capacity

Preparation of CUPRAC solution was adopted from Benzi¹⁵. The FRAP solution were prepared in acetate buffer pH 3.6. Various concentration of each extract were pipetted into FRAP solution 50 µg/ml (1:1) to initiate the reaction for obtaining a calibration curve. After 30 minutes incubation, the absorbance was read at wavelength 593 nm by using spectrophotometer UV-Vis Hewlett Packard 8435. Acetate buffer was used as a blank. FRAP solution 50 µg/ml was used as control. Ascorbic acid was used as standard. Analysis was done in triplicate for standard and each extract. Antioxidant capacity of each extract was determined based on increasing in Fe (II) - TPTZ absorbance by calculating percentage of antioxidant capacity¹⁵. EC₅₀ of FRAP capacity of each extract can be calculated using its calibration curve.

Total phenolic content (TPC) determination

Total phenolic content were measured using the modified Folin-Ciocalteu method adapted from Pourmorad¹⁶. The absorbance was read at wavelength 765 nm. Analysis was done in triplicate for each extract. Standard solution of gallic acid with concentration 40-165 µg/ml were used to obtain a standard curve. The total phenolic content was reported as percentage of total gallic acid equivalent per 100 g extract (g GAE/100 g).

Total flavonoid content (TFC) determination

Total flavonoid content was measured using adapted method from Chang *et al.*¹⁷. The absorbance was read at wavelength 415 nm. Analysis was done in triplicate for each extract. Standard solution of quercetin with concentration 36-120 µg/ml were used to obtain a standard curve. The total flavonoid content was reported as percentage of total quercetin equivalent per 100 g extract (g QE/100 g).

Total carotenoid content (TCC) determination

Total carotenoid content was measured using the modified carotene method adapted from Thaipong *et al.*¹. Each extract were diluted in n-hexane. The absorbance was read at wavelength 470 nm. Analysis was done in triplicate for each extract. Standard solution of beta carotene with concentration 15-55 µg/ml were used to obtain a standard curve. The total carotenoid content was

reported as percentage of total beta carotene equivalent per 100 g extract (g BE/100 g).

Statistical Analysis

Each sample analysis was performed in triplicate. All results presented are means (±SD) of at least three independent experiments. Statistical analysis (ANOVA with a statistical significance level set at $p < 0.05$ with post-hoc Tukey procedure was carried out with SPSS 16 for Windows. Correlations between the total phenolic, flavonoid and total carotenoid content and antioxidant capacities were made using the Pearson procedure ($p < 0.01$).

RESULTS

IC₅₀ of DPPH scavenging capacity and EC₅₀ of FRAP capacity

The IC₅₀ of DPPH scavenging capacities and EC₅₀ of FRAP capacities in various fruit extracts from three varieties of tomato using DPPH and FRAP assays were shown in Fig 1 and Fig 2. IC₅₀ of DPPH scavenging capacities and EC₅₀ of FRAP capacities of each extract were compared to IC₅₀ and EC₅₀ ascorbic acid as standard. The lowest EC₅₀ or IC₅₀ means had the highest antioxidant capacity.

TPC in various fruit extracts from three varieties of tomato

TPC among the various extracts were exposed in term of gallic acid equivalent using the standard curve equation $y = 0.004x + 0.0025$, $R^2 = 0.998$. The TPC in various fruit extracts from three varieties of tomato showed different result ranged from 0.43 to 6.27 g GAE/100 g. Ethyl acetate fruit extract of larisa variety (LA2) had the highest TPC (6.27 g GAE/100 g) (Fig 3).

TFC in various fruit extracts from three varieties of tomato

TFC among the various extracts were revealed in term of quercetin equivalent using the standard curve equation $y = 0.006x - 0.019$, $R^2 = 0.998$. The TFC in various fruit extracts from three varieties of tomato showed different result in the range of 0.92 – 5.13 g QE/100 g (Fig 4). N-hexane fruit extract of larisa variety (LA1) had the highest TFC (5.13 g QE/100 g) and the lowest (0.92 g QE/100 g) was given by ethanolic fruit extract of larisa variety (LA3).

TCC in various fruit extracts from three varieties of tomato

TCC among the various extracts were expressed in term of beta carotene equivalent using the standard curve equation $y = 0.015x + 0.002$, $R^2 = 0.9999$. The TCC in various fruit extracts from three varieties of tomato showed different result in the range of 0.19 – 58.74 g BE/100 g (Fig 5). The highest TCC (58.74 g BE/100 g) was given by n-hexane fruit extract of larisa variety (LA1), while the lowest carotenoid (0.19 g BE/100 g) for ethanolic fruit extract of bunch variety (BU3). Correlation between IC₅₀ of DPPH scavenging activities, EC₅₀ of FRAP capacities, total phenolic, flavonoid and carotenoid content in various fruit extracts from three varieties of tomato

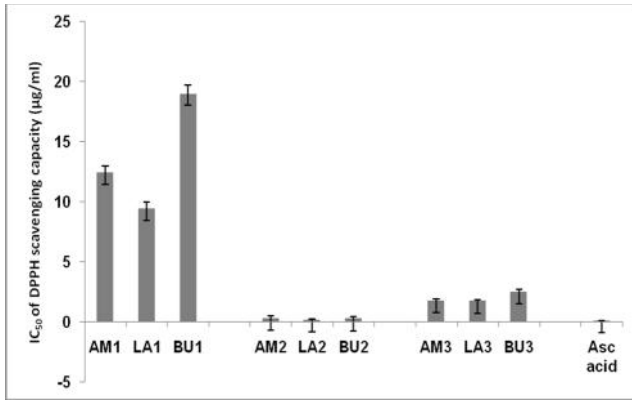


Figure 1: IC₅₀ of DPPH scavenging capacities in various fruit extracts from three varieties of tomato

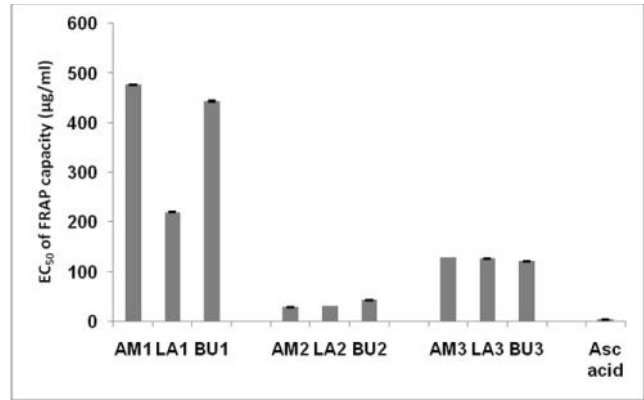


Figure 2: EC₅₀ of FRAP capacities in various fruit extracts from three varieties of tomato

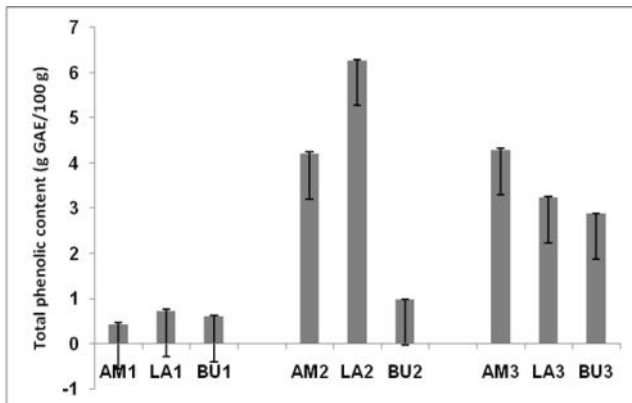


Figure 3: Total phenolic content in various tomato fruit extracts

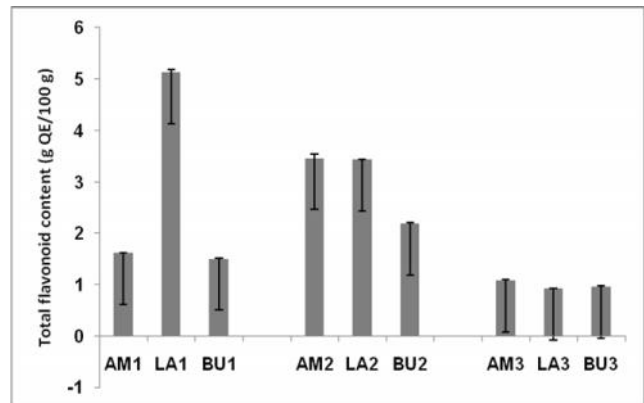


Figure 4: Total flavonoid content in various tomato fruit extracts

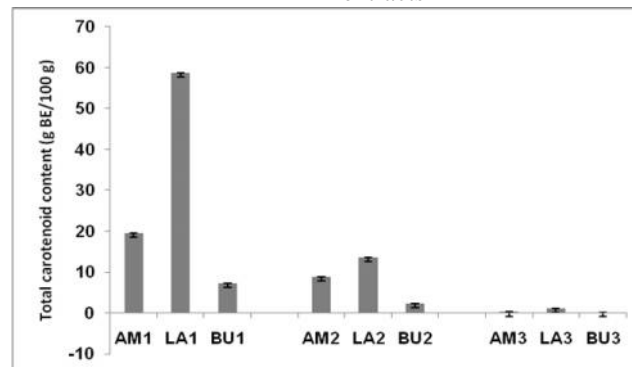


Figure 5: Total carotenoid content in various tomato fruit extracts

Pearson's correlation coefficient between TPC in various fruit extracts of three varieties of tomato and their antioxidant activities exposed that TPC in amala and larisa variety had negative and high correlation with IC₅₀ of DPPH scavenging activities ($r = -0.971$, $r = -0.909$, $p < 0.01$, respectively) and EC₅₀ of CUPRAC capacities ($r = -0.949$, $r = -0.998$, $p < 0.01$, respectively). Only TFC in larisa variety had highly positive correlation with IC₅₀ of DPPH scavenging activities ($r = 0.685$, $p < 0.05$) while TFC in other sample had no correlation with both of IC₅₀ of DPPH scavenging activities and EC₅₀ of FRAP capacities (Table 1).

DISCUSSION

The previous study^{1,4-5,8,11,18-19} revealed that fruits included tomato had antioxidant capacity. There were no study regarding antioxidant capacity of various extracts

(which were n-hexane, ethyl acetate and ethanol) of fruit from three varieties of tomato using DPPH and FRAP assays. The DPPH is stable free radicals which dissolve in methanol or ethanol, and its color show characteristic absorption at wavelength 515-520 nm. Color of DPPH would be changed when the free radicals were scavenged by antioxidant²⁰⁻²¹. Reagent of FRAP is FeCl₃ that combined with TPTZ in acetate buffer pH 3.6. Fe (III) will be reduced to Fe (II). Complex Fe (II) - TPTZ gives blue color and show characteristic absorption at wavelength 593 nm. Intensity of blue color is depends on amount of Fe (III) that is reduced to Fe (II). If a sample reduces Fe (III) to Fe (II), at the same time it will be oxidized, so that sample can act as antioxidant. Sample will act as antioxidant in FRAP assay if sample had reduction potential lower than reduction potential of Fe (III)/Fe (II) which was 0.77 V, so the sample had the

Table 1. Pearson's correlation coefficient of IC₅₀ of DPPH scavenging activities, EC₅₀ of FRAP capacities and total phenolic, flavonoid, carotenoid content in various fruit extracts of three varieties of tomato

	TPC	TFC	TCC	IC ₅₀ DPPH AM	DPPH	IC ₅₀ DPPH LA	IC ₅₀ DPPH BU
IC ₅₀ DPPH AM	-0.971**	-0.399 ^{ns}	0.837**				
IC ₅₀ DPPH LA	-0.909**	0.685*	0.928**				
IC ₅₀ DPPH BU	-0.54 ^{ns}	-0.173 ^{ns}	0.923**				
EC ₅₀ FRAP AM	-0.949**	-0.483 ^{ns}	0.775*	0.993**			
EC ₅₀ FRAP LA	-0.998**	0.376 ^{ns}	0.734*		0.928**		
EC ₅₀ FRAP BU	-0.475 ^{ns}	-0.248 ^{ns}	0.893**				0.996**

Note: IC₅₀ DPPH = IC₅₀ DPPH scavenging capacity, EC₅₀ FRAP = EC₅₀ FRAP capacity, AM = fruit extract of AM, LA = fruit extract of LA, BU = fruit extract of BU, ns = not significant, * = significant at p < 0.05, ** = significant at p < 0.01

reducing power to reduce Fe (III) to Fe (II) and this sample will be oxidized. IC₅₀ of DPPH scavenging capacity is concentration of sample or standard that can inhibit 50 % of DPPH scavenging capacity, while EC₅₀ of FRAP capacity is concentration of sample or standard that can exhibit 50 % of FRAP capacity. The lowest IC₅₀ or EC₅₀ means had the highest antioxidant capacity. IC₅₀ or EC₅₀ were used to determine antioxidant capacity of sample was compared to standard. Classification by Blois¹³ expressed that sample which had IC₅₀ or EC₅₀ lower than 50 µg/ml it was a very strong antioxidant, 50-100 µg/ml was a strong antioxidant, 101-150 µg/ml was a medium antioxidant, while a weak antioxidant with IC₅₀ or EC₅₀ higher than 150 µg/ml. In the present study exposed that IC₅₀ of DPPH scavenging capacities of various fruit extracts from three varieties of tomato ranged from 0.14 to 19.02 µg/ml. Ethyl acetate fruit extract of larisa variety (LA2) had the lowest IC₅₀ of DPPH scavenging capacity 0.14 µg/ml, while ascorbic acid standard gave IC₅₀ of DPPH scavenging capacity 0.11 µg/ml. Based on value of IC₅₀ of DPPH scavenging capacity it can be concluded that all of fruit extracts of tomato (amala, larisa and bunch varieties) can be categorized as very strong antioxidant. Its revealed that potency of LA2 was similar with ascorbic acid standard using DPPH method. Ethyl acetate fruit extract of amala variety (AM2) had the lowest EC₅₀ of FRAP capacity (28.91 µg/ml) while ascorbic acid standard gave EC₅₀ of FRAP capacity 3.68 µg/ml. Its demonstrated that potency of ascorbic acid was around eight times of potency of AM2 using FRAP assay. In the previous study²² expressed that ethanolic extract of yellow cherry tomato, red cherry tomato and tomato had IC₅₀ of DPPH scavenging capacities were 46.22, 46.47, 46.33 µg/ml, respectively, which was lower than IC₅₀ of DPPH scavenging activities of their methanolic extract. It was contrast with the current research which exhibited that ethanolic fruit extracts of amala, larisa and bunch varieties were 1.76, 1.72 and 2.49 µg/ml. Research by Mostapha⁹ revealed that percentage of DPPH scavenging activities of eight varieties of tomato (joker, kiti, nattih, tafna, zahra, agora, sammichele and marmande) gave different result by using different solvent (ethanol, 50 % ethanol, methanol, 50 % methanol). The result showed that joker variety which was extracted using ethanol had the highest percentage of DPPH scavenging activity

(65.09 %) and the lowest was given by sammichele variety in 50 % methanol (10.06 %). Generally, extract by using ethanol solvent gave higher percentage of DPPH scavenging activities than 50 % ethanol. The similar result was given by methanol and 50 % methanol⁹. Shahzad²³ demonstrated that percentage of DPPH scavenging activities of water extract of tomato and cherry tomato (44.65 % and 44.63 %, respectively) were higher than their methanolic extract (37.68 % and 35.80 %, respectively). The present study revealed that ethyl acetate fruit extracts of amala, larisa and bunch varieties had the lowest IC₅₀ DPPH scavenging activities and EC₅₀ of FRAP capacities compared to their n-hexane and ethanolic fruit extracts. In previous research²² stated that EC₅₀ of FRAP capacities of water extract of yellow cherry tomato, red cherry tomato and tomato was lower (3.32, 2.30 and 2.73 µM Fe (II)/g, respectively) than EC₅₀ of their ethanolic extract (7.87, 7.00 and 6.58 µM Fe (II)/g, respectively). Study by Mostapha⁹ exposed that methanolic extract of joker variety had the highest percentage of FRAP capacities (34 %) compared to its 50 % methanol, ethanol and 50 % ethanol extracts, while in the current study revealed that EC₅₀ of FRAP capacities of ethanolic fruit extracts of amala, larisa and bunch varieties were 128, 126 and 120 µg/ml, which was higher than their ethyl acetate fruit extracts (28, 29, 43 µg/ml, respectively). Methanolic extract of joker variety also showed the highest percentage of FRAP capacities compared to extract of kiti, nattih, tafna, zahra, agora, sammichele and marmande varieties⁹. Antioxidant capacity might be related with the presence of total phenolic content, included phenolic acid¹⁰. The previous study²⁵ found that TPC in acetone-water-acetic acid pulp extract of flavourine cultivar was the highest (15.2 mg GAE/100 g) compared to TPC of excell and tradiro cultivars (14.3 and 8.7 mg GAE/100 g, respectively). Study by Mostapha⁹ exposed that ethanolic extract of joker variety had the highest TPC (51.58 mg GAE/ 100 g) compared to its 50 % ethanol, methanol, 50 % methanol extract and also compared to other varieties (kiti, nattih, tafna, zahra, agora, sammichele and marmande) extracts. Previous study²² exhibited that TPC in ethanolic extract of yellow cherry tomato, red cherry tomato and tomato (5.07, 4.28, 4.25 mg GAE/g) were higher than their water extracts (1.55, 1.35, 1.39 mg GAE/g). TPC in ethyl acetate fruit extract of amala variety (AM2) 4.2 g GAE/100 g was higher than TPC in ethyl acetate fruit

extract of bunch variety (BU2) 0.98 g GAE/100 g, but IC_{50} of DPPH scavenging activities of AM2 was similar with BU2. Phenolic acid was included in phenolic groups. Cinnamic acid had higher antioxidant capacity than phenyl acetic acid and benzoic acid²⁴. Based on the data above might be many phenolic acid in BU2 were cinnamic acid groups which had high antioxidant capacity and almost all of phenolic acid in AM2 were benzoic acid which had low antioxidant capacity. TPC in AM2 (4.2 g GAE/100 g) was similar with AM3 (ethanolic fruit extract of amala variety) 4.29 g GAE/100 g, but EC_{50} of FRAP capacity of AM2 (28 $\mu\text{g/ml}$) was lower than EC_{50} of FRAP capacity (128 $\mu\text{g/ml}$). Based on this data it was supposed that many phenolic compounds in AM2 had reduction potential (E°) below 0.44 V that can reduce Fe(III) to Fe(II) and form complex with TPTZ then given blue color and only a little of phenolic compounds in AM3 had reduction potential below 0.44 V, so it can not reduce Fe(III) to Fe(II). Previous research by Toor²⁵ stated that TFC in skin extracts of three cultivar of tomato (excell, tradiro and flavourine) 20 -23 mg rutin eq/100 g were higher than their pulp and seeds extracts. It was contrast with the present study which showed that TFC in fruit extract of amara, larisa and buch varieties were 1.08, 0.92, 0.95 g GAE/100 g. Study by Atiqah²² demonstrated that TFC in ethanolic extracts of yellow cherry tomato, red cherry tomato and tomato (1.64-1.88 mg catechin/g) was similar with TFC in their water extracts. Flavonoid which have OH in A ring and or B ring will be included in phenolic groups. Flavonoid which had OH in ortho C 3',4', OH in C3, oxo function in C4, double bond at C2 and C3 would give higher antioxidant capacity. The OH with ortho position in C3'-C4' had the highest influence to antioxidant capacity of flavonoid. The flavonoid aglycones would give higher antioxidant capacity than flavonoid glycosides²⁴. It could be seen in Fig 4 that TFC in n-hexane fruit extract of bunch variety (BU1) 1.5 g QE/100 g was higher than TFC in ethanolic fruit extract of amala variety (AM3) 1.08 g QE/100 g, but IC_{50} of DPPH scavenging activity of AM3 (1.76 $\mu\text{g/ml}$) was lower than IC_{50} of DPPH scavenging activity of BU1 (19.02 $\mu\text{g/ml}$). Based on the data above it can be predicted that almost all of flavonoids in AM3 were flavonoid that had OH in position which can influence high antioxidant capacities. In contrast, BU1 contained many flavonoid which had OH in C5, C7, or C3' only, or C4' only, or C3 only without oxo function in C4, that had no and low antioxidant capacities. In the present study expressed that TCC in n-hexane, ethyl acetate and ethanol fruit extracts in amala, larisa and bunch varieties in the ranged from 0.19 to 58.74 g BE/100 g extract, which was higher than the Mostapha's research⁹ result that reported TCC in eight varieties of tomatoes in the range of 5.18-9.57 mg BE/100 g extract. Carotenoid had antioxidant capacity by scavenging free radical. More double bonds in carotenoid would give higher scavenging free radical capacity²⁶. Carotenoid that consisted of more than 7 double bonds gave higher scavenging radical capacity²⁷. Beta carotene was used as standard because of it had

conjugation double bonds which had ability to scavenge free radicals²⁸. In previous study²⁹ exposed that increasing in lipophilicity of carotenoid would increase scavenging radical capacity, it means give the lower IC_{50} of DPPH scavenging capacity. In Figure 5 it could be seen n-hexane fruit extract of larisa variety (LA1) 58.74 g BE/100 g was higher than ethyl acetate fruit extract of larisa variety (LA2) 13.65 g BE/100 g, but IC_{50} of DPPH scavenging activity of LA2 was lower (0.14 $\mu\text{g/ml}$) than LA1 (9.43 $\mu\text{g/ml}$). Based on the data above, it can be supposed that many carotenoid in LA2 had more than 7 double bonds and many carotenoid in LA1 had maximum 7 double bonds. Lycopene was effective to reduce Fe (III), because of it had 11 conjugated double bonds. Carotenoid such as phytoene, phytofluene, neurosporene that consisted of 3, 5 and 9 conjugated double bonds respectively, did not show significant capacity to reduce Fe (III)³⁰. TCC in n-hexane fruit extract of bunch variety (BU1) 7.29 g BE/100 g was similar with ethyl acetate fruit extract of amala variety (AM2) 8.89 g BE/100 g, but EC_{50} of FRAP capacity of AM2 (28.91 $\mu\text{g/ml}$) was lower than BU1 (442.68 $\mu\text{g/ml}$). It can be predicted that many carotenoid in AM2 had reduction potential lower than 0.44 V, so it can reduce Fe (III) to Fe (II) and at the same time it will be oxidized and it can act as antioxidant. Pearson's correlation coefficient was positively high if $0.61 \leq r \leq 0.97$ ¹ and negatively high if $-0.61 \leq r \leq -0.97$. Sample which had the lowest IC_{50} of DPPH scavenging activity or EC_{50} of FRAP capacity gave the highest antioxidant activity. So the good correlation between IC_{50} DPPH and or EC_{50} FRAP with TPC, TFC and TCC will be given in negatively and high correlation. It means increasing in TFC, TPC and TCC caused increasing in antioxidant activities, which was exposed by lower IC_{50} of DPPH scavenging activity and or EC_{50} of FRAP capacity. Previous study²² determined the correlation between TPC and TFC with percentage of DPPH scavenging activity and FRAP capacity. The result showed that both of ethanolic extracts and water extracts of yellow cherry tomato, red cherry tomato and tomato had no correlation with their IC_{50} of DPPH scavenging activities. FRAP capacity was reported by $\mu\text{M Fe(II)/g}$, so the good correlation would exposed in parallel position, increasing in TPC and TFC would give increasing in FRAP capacity. TPC and TFC in ethanolic extracts of yellow cherry tomato, red cherry tomato and tomato had positive and high correlation with FRAP capacity. Research by Mostapha⁹ expressed antioxidant activities using percentage of DPPH scavenging activities and percentage of FRAP capacities, so the good correlation would be demonstrated by positive and high correlation between TPC and percentage of DPPH scavenging activities and percentage of FRAP capacities. Based on the result of Mostapha's research it could be seen TPC in eight varieties of tomatoes had positively and high correlation with their percentage of DPPH scavenging activities and percentage of FRAP capacities. The data in Table 1 exposed that TPC in fruit extract of sample AM and LA had negatively and high correlation with IC_{50} of DPPH scavenging activities ($r = -0.971$, $r = -$

0.909, $p < 0.01$, respectively) and EC_{50} of FRAP capacities ($r = -0.949$, $r = -0.998$, $p < 0.01$, respectively). Based on this data it can be concluded that IC_{50} of DPPH of scavenging activity and EC_{50} of FRAP capacity of amala and larisa varieties can be predicted indirectly by determining their TPC. DPPH and FRAP methods had different mechanism reaction. Mechanism of DPPH that was electron transfer assay³¹ and FRAP was redox assay¹⁵. All of fruit extracts sample (amala, larisa and bunch varieties) exposed positively high correlation between IC_{50} of DPPH scavenging activities and EC_{50} of FRAP capacities. So the results of this study showed that IC_{50} of DPPH scavenging activities in all of extracts sample were linear with their EC_{50} of FRAP capacities.

CONCLUSION

Variety of methods should be used in parallel to assess the antioxidant capacity of sample, because different methods could give different results. All of fruit extracts of three varieties of tomato (amala, larisa and bunch) were very strong antioxidant. The negatively and high correlation between TPC with IC_{50} of DPPH scavenging capacities and EC_{50} of FRAP capacities were given by amala and larisa varieties. Phenolic compounds in fruit extracts of amala and larisa varieties were the major contributor in their IC_{50} of DPPH scavenging capacity and EC_{50} of FRAP capacity. There were linear correlation between IC_{50} of DPPH scavenging capacities and EC_{50} FRAP capacities result in all of fruit extracts sample. Three varieties of tomato (amala, larisa and bunch) may be exploited as natural antioxidant sources to alleviate oxidative stress.

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