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Research Article

Antioxidant activities from various bulbs extracts of three kinds allium using DPPH, ABTS assays and correlation with total phenolic, flavonoid, carotenoid content

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ABSTRACT

The antioxidant activities of various bulbs extracts of three kinds Allium were conducted by DPPH (2.2-diphenyl-1-picrylhydrazyl) and ABTS (2-2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) assays. Sample O2 (ethyl acetate extract of onion bulbs) had the highest DPPH scavenging capacity (45.86 %.) and the highest ABTS capacity (49.03 %). Sample RO2 (ethyl acetate extract of sample red onion) contained the highest total flavonoid (89.3 g QE/100 g) and the highest phenolic contents (40.75 g GAE/100 g), while the highest carotenoid 7.4 g BET/100 g was given by RO1 (n-hexane extract of sample red onion). Phenolic and flavonoid were the major contributors to antioxidant activity in onion and red onion bulbs. The total carotenoid of three Allium bulbs extracts had no significant correlation with DPPH and ABTS scavenging activities. There were positively high correlation between ABTS and DPPH scavenging capacities for sample O and RO, but no correlation for sample G (garlic).

Keywords: Antioxidants; DPPH; ABTS; Allium bulbs; flavonoid; phenolic; carotenoid

INTRODUCTION

Phenolic compounds are commonly found in plants, and they have been reported to have multiple biological effects, including antioxidant activity. Many studies had revealed that phenolic content in plants can be correlated to their antioxidant activities (Kujala *et al*., 2000). Fruits and vegetables such as onion, garlic, sweet potatoes are rich source of carotenoid, flavonoid and other phenolic compounds (Teow et al., 2007; Islam et al., 2003).

Some of antioxidant methods such as ABTS (2-2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) diammonium salt and DPPH (2,2-diphenyl-1 picrylhydrazyl were used to predict antioxidant capacity of fresh fruits, beverages and food (Leong, 2002; Gil, 2002). In previous study (Rahman, 2012) revealed that DPPH method could be used to examine antioxidant activity in garlic extract.

Study by Lanzotti (2006) demonstrated that total phenolic content of red onion (*Allium cepa* L. var. *ascalonicum* Backer) higher than garlic (*Allium sativum* L.) and onion (*Allium cepa* L. var. *cepa*). The previous research regarding three varieties of garlic illustrated that flavonoid and steroid of garlic extract had contribution in antioxidant capacities (Narendhirakaman, 2010). The previous study by Najja *et al*. (2011) showed that DPPH scavenging activity of *Allium roseum* was similar with its ABTS scavenging capacity.

The objective of this research were to study antioxidant activity of various extracts (n-hexane, ethyl acetate and ethanol) of three kinds Allium (*Allium cepa* L. var. *cepa*, *Allium sativum* L and *Allium cepa* L. var. *ascalonicum* Backer) bulbs using simple methods of antioxidant testing DPPH and ABTS assays and correlations of their activity with total flavonoid, phenolic, and carotenoid contents in each extracts.

MATERIALS AND METHODS

Chemicals

ABTS (2-2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) diammonium salt, DPPH (2,2-diphenyl-1 picrylhydrazyl), gallic acid, quercetin, beta carotene was purchased from Sigma-Aldrich (MO, USA), potassium persulfate, methanol, ethanol. All other reagents were analytical grades.

Preparation of leaves for analysis

Bulbs of three kinds Allium were bought from Caringin market in Bandung that were onion (*Allium cepa* L. var. *cepa*) from India, garlic (*Allium sativum* L.) from China and red onion (*Allium cepa* L. var. *ascalonicum* Backer). Onion bulbs (call as O), garlic bulbs (G) and red onion bulbs (RO) were thoroughly washed with tap water, wet sortation and dried. The samples were cutting by food processor and taken three days for drying process

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at temperature 40ºC. Then the dried samples were grinding into powder.

Extraction

Three hundred grams of powdered samples were extracted with reflux techniques 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 O1, G1 and RO1), three ethyl acetate extracts (O2, G2 and RO2) and three ethanolic extracts (O3, G3 and RO3)

DPPH scavenging capacity

Preparation of DPPH solution were adopted from Blois (1958) with minor modification. 2.5 mg DPPH were diluted into 50 mL methanol. The mixture were incubated in the dark room for 30 minutes. Keep the radical stock solution of DPPH in refrigerator (4ºC). Each extracts with concentration 50 μg/mL was pipetted into DPPH solution concentration 50 μg/mL (1:1) to initiate the reaction. The absorbance was read at wavelength 516 nm after 30 minutes incubation using Hewlett Packard 8435 spectrophotometer UV-Vis. Methanol was used as a blank and DPPH solution 50 μg/mL as standard. Analysis was done in triplicate for standard and each extracts. All measurement procedures were in dark room. Antioxidant activity of each extracts were determined based on the reduction of DPPH absorbance by calculating percentage of antioxidant activity (Bedawey, 2010)

ABTS scavenging capacity

Preparation of ABTS radical solution were adopted from Li *et al*. (2011) and Pellegrini *et al*. (2003) method with minor modification. ABTS diammonium salt aqueous solution with concentration 2.5 mg/5 mL and potassium persulfate aqueous solution 2.5 mg/5 mL was prepared. Each solutions allowing to stand in the dark room for 12-18 hours. A radical stock solution of ABTS was produced by mixing two above solutions and ad to 50 mL with ethanol 95%. ABTS solution would give absorbance 0.71 ± 0.2 at wavelength 734 nm, verified by Hewlett Packard 8435 Diode Array Spectrophotometer (HP, Waldbronn, Germany). 0.3 mL of each extracts 50 μg/mL was pipetted into 0.3 mL ABTS solution 50 μg/mL (1:1) to initiate the reaction. The mixture was diluted with 1.4 mL ethanol. The absorbance was read at wavelength 734 nm without incubation time using Hewlett Packard 8435 spectrophotometer UV-Vis. Ethanol (95%) was used as a blank and ABTS solution 50 μg/mL was used as standard. Analysis was done in triplicate for standard and each extracts. All measurement procedures were in dark room. Antioxidant capacity of each extracts were determined based on the reduction of ABTS absorbance by calculating percentage of antioxidant activity (Bedawey, 2010)..

Total flavonoid determination

Total flavonoid content was measured using adapted method from Chang *et al* (2002). Extracts 0.5 mL was pipetted into 0.1 mL aluminium chloride 10%, 0.1 mL sodium acetate 1M and 2.8 mL aquadest. The mixture were diluted with 1.5 mL ethanol, and incubated for 15 minutes. The absorbance was read at wavelength 415 nm. Analysis was done in triplicate for each extracts. Standard solutions of quercetin with concentration 40-100 μg/mL were used to obtain a standard curve. The total flavonoid content was reported as percentage of total quercetin equivalents per 100 g extract (g QE/100 g).

Total phenolic determination

Total phenolic content were measured using the modified Folin-Ciolcalteu method adapted from Pourmorad (2006). Extracts 0.5 mL was pipetted into 5 mL Folin-Ciolcalteu reagent (1:10) and 4 mL sodium carbonate 1 M. The mixtures were incubated for 15 minutes. The absorbance was read at wavelength 765 nm. Analysis was done in triplicate for each extracts. Standard solutions of gallic acid with concentration 60-150 μg/mL were used to obtain a standard curve. The total phenolic content was reported as percentage of total gallic acid equivalents per 100 g extract (g GAE /100 g).

Total carotenoid determination

Total carotenoid content was measured using the modified carotene method adapted from Thaipong *et al* (2006). Each extracts were diluted into n-hexane solvent. Extracts 2 mL were measured and the absorbance was read at wavelength 470 nm. Analysis was done in triplicate for each extracts. Standard solutions of beta carotene with concentration 10-80 μg/mL were used to obtain a standard curve. The total carotenoid content was reported as percentage of total beta carotene equivalents per 100 g extract (g BET/100 g).

RESULT AND DISCUSSION

Lanzotti (2006) demonstrated that total phenolic content of garlic (*Allium sativum* L.) and onion (*Allium cepa* L. var. *cepa*) lower than red onion (*Allium cepa* L. var. *ascalonicum* Backer. Study by Narendhirakaman (2010) regarding three varieties of garlic illustrated that flavonoid and steroid of garlic extract had contribution in antioxidant capacities.

In previous study (Rahman, 2012) revealed that antioxidant capacity in garlic extract could be determine by using DPPH method. Study by Najja *et al*. (2011) regarding *Allium roseum* leaves extract showed that DPPH scavenging activity was linear with its ABTS scavenging capacity and had high correlation with its total phenolic content. Yang *et al* (2004) found that total phenolic in onion and red onion had high correlation with antioxidant activity. There were no study regarding antioxidant activity of three different polarity extracts (which were n-hexane, ethyl acetate and etha-

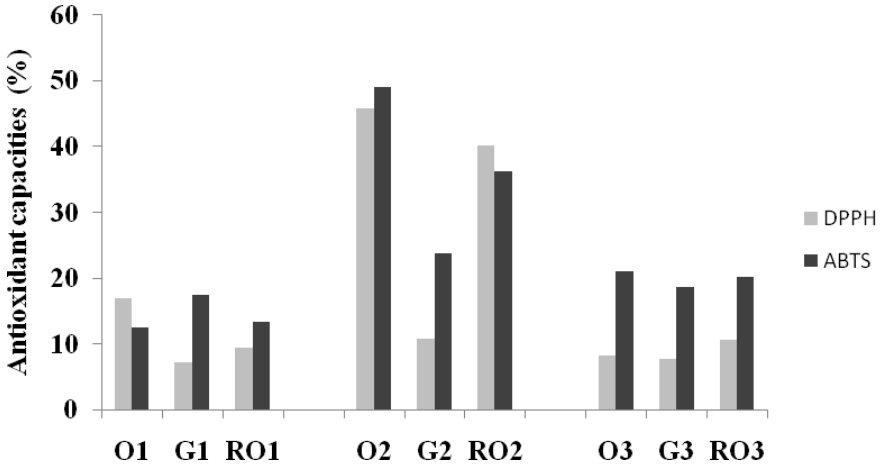

Figure 1: Antioxidant capacities of various bulbs extracts of three kinds Allium with DPPH and ABTS assays

Table 1: DPPH and ABTS scavenging activities of **n-hexane bulbs extracts**

Sample	DPPH scavenging activity (%)	ABTS scavenging activity (%)
O1	16.88 ± 6.10 a	12.47±4.94 a
G1	7.13 ± 4.05 a	17.43±4.86 a
RO1	9.40 ± 4.23 a	13.26±4.73 a
P value	< 0.05	< 0.05

a = means within a column with the same letter were not significantly different (p=0.05).

nol) of three kinds Allium bulbs using DPPH and ABTS assays.

Antioxidant capacities of various bulbs extracts of three kinds Allium with DPPH and ABTS assays

Both of DPPH and ABTS are stable free radicals which dissolve in methanol or ethanol, and their colors show characteristic absorption at wavelength 519 nm or 734 nm, respectively. When an antioxidant scavenges the free radicals by hydrogen donation, the colors in the DPPH and ABTS assays solution become lighter (Li *et al*., 2011; Apak *et al*., 2007). DPPH and ABTS assays have been widely used to determine the free radical scavenging activity of extracts. Both of DPPH and ABTS procedures are simple to perform (Teow *et al*., 2007).

The antioxidant capacities of various bulbs extracts of three kinds Allium using DPPH and ABTS assays were shown in Fig.1. In the DPPH method, radical scavenging activities of various extracts ranged from 7.68 to 45.86 %. O2 bulbs extract (ethyl acetate extract of onion bulbs) had the highest DPPH radical scavenging activity (45.86%), while Q3 bulbs extract (7.68%) had the lowest DPPH antioxidant activity.

In ABTS method, antioxidant activities of various bulbs extracts of three kinds Allium in the range of 12.47-49.03 %. O2 bulbs extract (ethyl acetate extract of onion) had the highest ABTS scavenging activity (49.03 %), while the lowest activity (12.47 %) was given by O1 (n-hexane extract of onion) bulbs extract. According to Rabinowitch and Kamenetsky (2002), red onion bulbs had more highly active compounds than onion bulbs. Benkeblia (2007) reported that non-polar sub-fractions of the extracts did not show any antioxidant potential, while the polar sub-fractions exhibited the activity. Previous study revealed that n-hexane extract of red onion and garlic had higher antioxidant capacities than water extract (Leelarungrayub *et al*., 2006)

Statistical analysis of scavenging radical DPPH and ABTS activities among n- hexane bulbs extracts were shown in Table 1. All of n-hexane extracts O1, G1 and RO1 indicated that DPPH and ABTS scavenging capacities were not significantly different from each other.

The DPPH and ABTS scavenging radical capacity among ethyl acetate bulbs extract (Table 2) demonstrated that O2 and RO2 not significantly different from each other and both of them significantly different with G2 (p< 0.05).

Statistical analysis of DPPH and ABTS scavenging activitis among ethanolic bulbs extract showed that all of samples O3, G3 and RO3 were not significantly different from each other.

Total flavonoid content of various bulbs extracts of three kinds Allium

The total flavonoid contents among the different varieties were expressed in term of quercetin equivalent using the standard curve equation. The flavonoid contents shown as percentage of total flavonoid extract (g QE/100 g). Total flavonoid content in ethyl acetate extract and ethanolic extract were illustrated in Table 4. The total flavonoid contents of bulbs extracts in three kinds Allium shown different result in the range of 2.64 – 89.3 g QE/100 g. The total flavonoid contents was highest (89.3 g QE/100 g) for RO2 bulbs extracts, followed by O2 bulbs extract (66.74 g QE/100 g), and the lowest (2.64 g QE/100 g) for O3 bulbs extract.

Table 2: DPPH and ABTS scavenging activities of ethyl acetate bulbs extracts

Sample	DPPH scavenging activity (%)	ABTS scavenging activity (%)
O2	45,86±3,38 a	49,03±4,37 a
G2	10,73±1,20 b	23,69±4,93 b
RO2	40,22±3,06 a	36,25±4,44 a
P value	< 0.05	< 0.05

a-b = means within a column with the same letter were not significantly different (p=0.05).

Table 3: DPPH and ABTS scavenging activities of ethanolic bulbs extracts

Sample	DPPH scavenging activity (%)	ABTS scavenging activity (%)
O3	8,23±3,10 a	21,01±4,93 a
G3	7,68±2,66 a	18,68±4,93 a
RO3	10,67±2,68 a	20,25±4,60 a
P value	< 0.05	< 0.05

a = means within a column with the same letter were not significantly different (p=0.05).

Statistical analysis for total flavonoid contents among in ethyl acetate bulbs extract showed that all of samples O2, G2 and RO2 significantly different from each other (p< 0.05). The total flavonoid contents in ethanolic bulbs extract indicated that O3 and G3 not significantly different and both of them significantly different with RO3 (p<0.05).

Total phenolic content of various bulbs extracts of three kinds Allium

The total phenolic contents among the different varieties were expressed in term of gallic acid equivalent using the standard curve equation. The phenolic contents shown as percentage of total phenolic extract (g GAE/100 g). The total phenolic contents of three Allium bulbs shown different result ranged from 4.40 to 40.75 g GAE/100 g. Total phenolic content in bulbs extracts were illustrated in Table 5.

RO2 bulbs extract (ethyl acetate extract of onion bulbs) had the highest phenolic contents (40.75 g GAE/100g), followed by O2 bulbs extract (40.3 g GAE/100 g). Study by Lanzotti (2006) demonstrated that total phenolic content of red onion (*Allium cepa* L. var. *ascalonicum* Backer) higher than garlic (*Allium sativum* L.) and onion (*Allium cepa* L. var. *cepa*). It was similar with the result of this study. Horng *et al* (2005) showed total phenolic content of ethyl acetate fraction was higher than butanol fraction and water fraction and also similar with this study that showed the total phenolic content of ethyl acetate extracts was higher than n-hexane extracts and ethanol extracts.

Statistical analysis for total phenolic contents among in n-hexane bulbs extract showed all of samples O1, G1 and RO1 not significantly different from each other. The total phenolic content in ethyl acetate bulbs extract demonstrated that O2 and RO2 not significantly different from each other and G2 signicantly different to O2 and RO2 (p<0.05). In ethanolic bulbs extract indicated that O3, G3 and RO3 not significantly different from each other.

Total carotenoid content of various bulbs extracts of three kinds Allium

The total carotenoid contents among the different varieties were expressed in term of beta carotene equivalent using the standard curve equation. The carotenoid contents shown as percentage of total carotenoid extract (g BET/100 g). The total carotenoid contents of bulbs extracts in three kinds Allium shown different result in the range of 0.16 -7.40 g BET/100 g.

The highest carotenoid contents (7.40 g BET/100 g) for RO1 bulbs extract, followed by O1 bulbs extract (5.20 g BET/100 g), while the lowest carotenoid (0.16 g BET/100 g) for RO3 bulbs extract.

Statistical analysis for carotenoid contents in bulbs leaves extract were shown in Table 6. The total carotenoid in all of samples n-hexane bulbs extract (O1, G1 and RO1) significantly different (p<0.05) from each other. Total carotenoid contents in ethyl acetate bulbs extract indicated that G2 and RO2 not significantly different. Both of them significantly different with O2 (p<0.05). In ethanolic leaves extract, the total carotenoid contents O3 and RO3 not significantly different from each other and both them significantly different with G3 (p<0.05).

Correlations of total phenolic, flavonoid, carotenoid content and DPPH, ABTS scavenging capacities in onion bulbs extracts

Pearson's correlation coefficient was positively high if $0.61 \leq r \leq 0.97$ (Thaipong, 2006). There were positively high correlation between total phenolic content in onion bulbs extracts with DPPH scavenging capacities (r = 0.965, p<0.01) and ABTS capacities (r = 0.941, p<0.01) (Table 7). Total flavonoid content in onion bulbs extracts demonstrated high and positive correlation with DPPH scavenging activities (r = 0.993, p<0.01) and ABTS capacities (r = 0.963, p<0.01). There were no correlation between total carotenoid in onion bulbs extracts with DPPH and ABTS scavenging capacities. Total flavonoid content in onion bulbs extracts had high correlation with total phenolic content. DPPH scavenging ac-

Table 4: Total flavonoid content in bulbs extracts

Sample	Total flavonoid in ethyl acetate extract	Total flavonoid in ethanolic extract
	(g QE/ 100 g)	(g QE/ 100 g)
O	66,74±1,3 a	2,64±0,16 a
G	4,37±0,24 b	2,75±0,38 a
RO	89,3±1,45 c	7,09±0,41 b
P value	< 0.05	< 0.05

a-c = means within a column with the same letter are not significantly different (p=0.05).

Table 5: Total phenolic content in bulbs extracts

Sample	Total phenolic in n-hexane extract	Total phenolic in ethyl acetate extract	Total phenolic in ethanolic extract
	(g GAE/ 100 g)	(g GAE/ 100 g)	(g GAE/ 100 g)
O	4,4±2,10 a	40,3±1,28 a	8,31±1,83 a
G	5,73±1,17 a	11,79±1,06 b	7,84±1,25 a
RO	6,32±1,2 a	40,75±0,33 a	8,56±0,66 a
P value	< 0.05	< 0.05	< 0.05

a-b = means within a column with the same letter are not significantly different (p=0.05).

Table 6: Total carotenoid content in bulbs extracts

Sample	Total carotenoid in n-hexane extract	Total carotenoid in ethyl acetate extract	Total carotenoid in ethanolic extract
	(g BET/ 100 g)	(g BET/ 100 g)	(g BET/ 100 g)
O	5,2±0,15 a	0,60±0,20 a	0,20±0,05 a
G	2,32±0,24 b	2,93±0,25 b	0,52±0,04 b
RO	7,4±0,15 c	2,84±0,21 b	0,16±0,01 a
P value	< 0.05	< 0.05	< 0.05

a-c = means within a column with the same letter are not significantly different (p=0.05).

Table 7: Pearson's correlation coefficient of total phenolic, total carotenoid, total flavonoid and DPPH scavenging activity in onion bulbs extracts

	TPH	TBC	TFL	DPPH
TBC	-0.446 ^{ns}	--	--	--
TFL	0,998**	0.838*	--	--
DPPH	0,965**	-0.231 ^{ns}	0,993**	--
ABTS	0,941**	-0.616 ^{ns}	0,963**	0.84**

TPH = total phenolic, TBC = total carotenoid, TFL= total flavonoid, DPPH = DPPH scavenging activity, ABTS = ABTS scavenging activity, * = significant at p < 0.05, ** = significant at p < 0.01, ns = not significant

tivities in onion bulbs extracts had high correlation with ABTS activities.

Correlations of total phenolic, flavonoid, carotenoid content and DPPH, ABTS scavenging capacities in garlic bulbs extracts

There were positive and high correlation between total phenolic content in garlic bulbs extracts with DPPH scavenging capacities (r = 0.818, p<0.01) and no correlation with ABTS activities (Table 8). Total flavonoid content in garlic bulbs extracts demonstrated positively high correlation with DPPH scavenging activities (r = 0.848, p<0.05) and no correlation with ABTS capacities. There were no correlation between total carotenoid in garlic bulbs extracts with DPPH and ABTS scavenging capacities. Total flavonoid content in onion bulbs extracts had high correlation with total phenolic content. There was no correlation between DPPH activities in garlic bulbs extracts ABTS scavenging activities. Study by Narendhirakannan (2010) reported that garlic bulb extracts contained flavonoid and steroids which were known as antioxidants.

There were positively high correlation between total phenolic content in red onion bulbs extracts with DPPH scavenging capacities (r = 0.987, p<0.01) and ABTS capacities (r = 0.917, p<0.01) (Table 9). Total flavonoid content in red onion bulbs extracts illustrated high and positive correlation with DPPH scavenging activities (r = 0.99, p<0.01) and ABTS capacities (r = 0.914, p<0.05). There were no significant correlation between total carotenoid in red onion bulbs extracts with DPPH and ABTS scavenging capacities. DPPH scavenging activities in red onion bulbs extracts had high correlation with ABTS activities. The onion had highest total quercetin content than red onion (Patil, 1995). Nencini (2011) have found positive correlation between total phenolic content (TPC) in Allium species and the antioxidant

Table 8: Pearson's correlation coefficient of total phenolic, total carotenoid, total flavonoid and DPPH scavenging activity in garlic bulbs extracts

	TPH	TBC	TFL	DPPH
TBC	0,451^{ns}	--	--	--
TFL	0,984**	0,95**	--	--
DPPH	0,818**	0,254^{ns}	0,848*	--
ABTS	0,644^{ns}	0.249^{ns}	0,599^{ns}	0,546^{ns}

TPH = total phenolic, TBC = total carotenoid, TFL= total flavonoid, DPPH = DPPH scavenging activity, ABTS = ABTS scavenging activity, * =significant at p < 0.05, ** = significant at p < 0.01, ns = not significant

Table 9: Pearson's correlation coefficient of total phenolic, total carotenoid, total flavonoid and DPPH scavenging activity in red onion bulbs extracts

	TPH	TBC	TFL	DPPH
TBC	-0,241^{ns}	--	--	--
TFL	1**	0,995**	--	--
DPPH	0,987**	-0,214^{ns}	0,99**	--
ABTS	0,917**	-0,431^{ns}	0,914*	0,928**

TPH = total phenolic, TBC = total carotenoid, TFL= total flavonoid, DPPH = DPPH scavenging activity, ABTS = ABTS scavenging activity, * =significant at p < 0.05, ** = significant at p < 0.01, ns = not significant

activity evaluated with DPPH test. Najja (2011), significant correlations were observed between total phenolic content (TPC) of *Allium roseum*, and antioxidant activity (R^2=0.828 for TPC vs. DPPH and R^2=0.925 for TPC vs. ABTS), suggesting that polyphenolic compounds are the major contributors to the antioxidant capacity. Singh (2009) found the potent antioxidant effects of polyphenolics including ferulic, gallic and protocatechuic acids, quercetin and kaempferol in garlic peel.

According to Leelarungrayub (2006), the antioxidant activity in red onion depends largely on the polyphenolic compounds and diallyl disulfide in the bulbs. A good correlation was found between DPPH and ABTS methods (R^2=0.827) in *Allium roseum*, indicated that these two methods gave consistent results for *Allium roseum* (Najja, 2011).

In general, free radical scavenging effect of phenolics depends mainly on number and position of hydrogen-donating hydroxyl groups on aromatic ring of phenolic molecules (Cai, 2004). Flavonoid would give antioxidant activity which had OH in ortho C 3',4', OH in C 3, oxo function in C 4, double bond at C 2 and C 3 (Heim, 2002). The previous study demonstrated that antioxidant activity of flavonoids increased with 7,8-dihydroxy group in the A-ring (Horng, 2005). Yang (2004) found that phenolic and flavonoid content in red onions and onions had strong correlations with the antioxidant activities.

CONCLUSION

Ethyl acetate extract of onion bulbs had the highest DPPH and ABTS scavenging activities and thus onion bulbs as the potential source for antioxidant. The positively high correlation between total phenolic, total flavonoid content with DPPH and ABTS scavenging activities were given by onion (*Allium cepa var ascalonicum*) and red onion (*Allium cepa var cepa)*. There were no significant correlation between total carotenoid with DPPH and ABTS scavenging capacities that given by all of samples (onion, red onion and garlic). Antioxidant activity measured in onion and red onion bulbs extracts may also be estimated indirectly by using total phenolic and total flavonoid since they showed positively high correlation with the DPPH and ABTS scavenging activities. Phenolic and flavonoid were the major contributors to antioxidant activity in onion and red onion bulbs.

REFERENCES

Apak R, Kubilay G, Birsen D, Mustava O, Saliha EC, Burcu B, Berker KI, Dilek O. Comparative Evaluation of Various Total Antioxidant Capacity Assays Applied to Phenolic Compounds with the CUPRAC Assay, Molecules 2007; 12: 1496-1547

Bedawey AA. Characteristics of antioxidant isolated from some plants sources, Cairo: ShibinEl-Kom, 2010, pp. 1-11

Benkeblia N, Virginia L, Allium Thiosulfinates: Chemistry, Biological Properties and their Potential Utilization in Food Preservation, Global Science Books, Food, 2007; 1(2): 193-201

Blois MS. Antioxidant Determination by the use of Stable Free radicals, Nature 1958; 181: 1199-2000

Cai Y, Luo Q, Sun M, Corke H. Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer, Life Sci. 2004; 74: 2157-2184

Chang CC, Yang MH, Wen HM et al. Estimation of Total Flavonoid Content in Propolis by Two Complementary Colorimetric Methods, J Food Drug Anal. 2002; 10: 178-182

Gil M I, Barberan T., Pierce FA, Kader AA. Antioxidant Capacities, Phenolic Compounds, Carotenoids, and Vitamin C contents of nectarine, peach and plum cultivars from California, J. Agr. Food Chem. 2002; 50: 4976-4982.

Heim KE, Tagliaferro AR, Bobilya D.J. Flavonoid antioxidants: chemistry, metabolism and structure-activity relationship. J Nutri Biochem. 2002; 13: 572-584

Herrmann, K. Flavonols and Flavones in Food Plants: A Review, J. Food Technol. 1976; 11: 433-448

Horng J, Yu W, Sheng YW, Fen L, Hsiung YS, Tzen SC. Phenolic Antioxidants from the Heartwood of Acacia confuse, J. Agric. Food Chem. 2005; 53: 5917-5921

Islam MS., Yoshimoto M., Ishigure K et al. Effect of artificial shading and temperature on radical scavenging activity and polyphenolic composition in sweet potato (*Ipomoea batatas* L.) leaves. J Am Soc Hortic Sci. 2003; 128: 182-187

Kujala TS, Loponen JM, Klika KD, Pihlaja K. Phenolics and Betacyanins in Red Beetroot (*Beta vulgaris*) root: distribution and effect of cold storage on the content of total phenolics and three individual compounds, J. Agric. Food. Chem. 2000; 48: 5338-5342

Lanzotti V. The Analysis of Onion and Garlic, Journal of Chromatography A, 2006; 1112: 3-22

Leelarungrayub N, Rattanapanone V, Chanart N, Gebicki JM. Quantitative Evaluation of Antioxidant Properties of Garlic and Shallot Prepararations, Nutrition, 2006; 22: 266-274.

Leong LP, Shui G, An Investigation of Antioxidant Capacity of Fruits in Singapore Markets, Food Chem. 2002; 76: 69-75.

Li XC, Wang XZ, Chen DF et al. Antioxidant activity and mechanism of protochatechuic acid in vitro, Journal of Functional Food in Health and Disease 2011; 1: 232-244

Najja H, Zerria K, Fattouch S, Ammar E. Neffati M, Antioxidant and Antimicrobial Activities of *Allium roseum* L. “Lazoul”, a wild edible endemic species in North Africa,.Int. J. Food Prop. 2011; 14: 371-380

Narendhirakannan RT, Rajeswari K. In Vitro Antioxidant Properties of Three Varieties of *Allium sativum* L. Extracts, E-Journal of Chemistry, vol.7, no.1, 2010 pp. 573-579

Nencini C, Menchiari A, Franchi GG, Micheli L. In Vitro Antioxidant Activity of Aged Extracts of Some Italian Allium species, Plant. Foods Hum. Nutr. 2011; 66: 11-16

Patil BS, Leonard MP, and Kill SY, Variations in the Quercetin Content in Different Colored Onions (*Allium cepa* L.), J. Amer. Soc. Hort. Sci. 1995; 120 (6): 909-913

Pellegrini N, Serafini M, Colombi B et al. Total antioxidant capacity of plant food, Beverages and oils consumed in Italy assessed by three different in vitro assays. J Am Coll Nutr. 2003; 133: 2812-2819

Pourmorad F, Hosseinimehr SJ, Shahabimajd N. Antioxidant activity, phenol and flavonoid content of some selected Iranian medicinal plants, Afr J Biotechnol., vol. 5, no.11, 2006 pp. 1142-1145

Rabinowitch HD, Kamenetsky R. Shallot (*Allium cepa*, Aggregatum group). In: Rabinowitch HD, Currah L (eds) Allium crop science: recent advances. CABI Publishing, Wallingford, 2002, pp 409-430

Rahman MM, Fazlic V, and Saad NW. Antioxidant Properties of raw Garlic *(Allium sativum)* extract, International Food Research Journal, vol.19, no.2, 2012 pp. 589-591

Singh BN, Singh BR, Singh RL, Prakash D, Singh DP, Sarma BK, Upadhyay G, Singh HB, Polyphenolics from varios extracts/fractions of red onion (*Allium cepa*) peel with potent antioxidant and antimutagenic activities, Food Chem Toxicol, 2009; 47 (6): 1161-1167

Teow CC., Truong VD., Mcfeeters RF et al. Antioxidant activities, phenolic and β-carotene contents of sweet potato genotypes with varying flesh colors. Food Chem. 2007;103: 829-838

Thaipong K, Boonprakob U, Crosby K et al. Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts, J Food Comp Anal. 2006; 19: 669-675

Yang J, Meyers KJ, Heide J, Liu RH. Varietal Differences in Phenolic Content and Antioxidant and Antiproliferative Activities of Onion,. J. Agric. Food Chem. 2004; 52: 6787-6793.