https://ijrps.com

ISSN: 0975-7538
Research Article

Evaluation of antioxidant activities from various extracts of Dragon fruit peels using DPPH, ABTS assays and correlation with phenolic, flavonoid, carotenoid content

Irda Fidrianny*, Nadiya Sahar A, Komar Ruslan W

School of Pharmacy, Bandung Institute of Technology, Indonesia

ABSTRACT

The antioxidant capacities from various extracts of dragon fruit peels were conducted by DPPH (2.2-diphenyl-1-picrylhydrazyl) and ABTS (2-2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) assays. Sample WH2 (ethyl acetate peels extract of white dragon fruit) had the highest DPPH scavenging capacity (53.87 %) and the highest ABTS capacity (72.47 %). Sample HB2 (ethyl acetate peels extract of hybrid dragon fruit) contained the highest total flavonoid (9.85 g QE/100 g), the highest phenolic contents (4.55 g GAE/100 g) for SR3 (ethanolic peels extract of super red dragon fruit), while the highest carotenoid 1.51 g BET/100 g was given by SR1 (n-hexane peels extract of super red dragon fruit) and WH1 (n-hexane peels extract of white dragon fruit). The total phenolic and total flavonoid content in sample WH (white dragon fruit peels extract) had positively high correlation with its DPPH and ABTS scavenging capacities. The total carotenoid of three dragon fruit peels extracts had no correlation with DPPH and ABTS scavenging activities. DPPH scavenging capacities in hybrid dragon fruit peels extract had positively high correlation with their ABTS scavenging activities.

Keywords: Antioxidants; DPPH; ABTS; dragon fruit peels; flavonoid; phenolic; carotenoid

INTRODUCTION

Oxidative stress can be protected by antioxidant on account of their high antioxidant activity (Jain, 2011). Phenolic compounds such as phenolic acid, flavonoid and tannin have been reported to have multiple biological effects, including antioxidant activity (Jain, 2011; Mallick, 2007; Thaipong, 2006). Many studies had exposed that antioxidant activities could be correlated with their phenolic and or flavonoid content in plants. Plants contained phenolic and polyphenol compounds which have antioxidant activity (Adnan, 2011; Jain, 2011; Lin, 1999).

Some of antioxidant methods such as DPPH (2,2-diphenyl-1 picrylhydrazyl) and ABTS ((2-2'-azinobis (3-ethyl-benzothiazoline-6-sulfonic acid) were widely used to predict antioxidant capacity of fresh fruits, beverages and food (Thaipong, 2006). In previous study (Luis, 2012; Souri, 2008; Thaipong, 2006) revealed that DPPH and ABTS methods could be used to determine antioxidant activity in many plants extracts. The previous study (Adnan, 2011; Agbor, 2011; Choo, 2011; Huang, 2012; Luo, 2014; Nurliyana, 2010; Rebecca, 2010; Souri, 2008) showed antioxidant activities of some plants including dragon fruit peels.

The objective of this research were to study antioxidant capacities of various extracts (n-hexane, ethyl acetate and ethanol) from three dragon fruit (hybrid, super red and white) peels using antioxidant testing DPPH and ABTS assays and correlations of their capacities with total flavonoid, phenolic, and carotenoid content in each extracts.

MATERIALS AND METHODS

Materials

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

Preparation of sample

Fruits peels of three dragon fruit (*Hylocereus sp*) that were: red dragon fruit (hybrid) *Hylocereus polyrhizus* (namely HB), super red dragon fruit *Hylocereus costaricensis* (namely SR) and white dragon fruit *Hylocereus undatus* (WH) collected from Keboen Nogo, Malang, 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 sol-

* Corresponding Author
Email: irda@fa.itb.ac.id
Contact: +62-22-2504852
Received on: 27-05-2014
Revised on: 23-06-2014
Accepted on: 29-06-2014

vents. 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 HB1, SR1, WH1), three ethyl acetate extracts (HB2, SR2, WH2) and three ethanolic extracts (HB3, SR3, WH3).

DPPH scavenging capacity

Preparation of DPPH solution were adopted from Molyneux (2003) and Blois (1958) with minor modification. Each extract 50 μg/mL was pipetted into DPPH solution concentration 50 μg/mL (1:1) to initiate the reaction. After 30 minutes incubation, the absorbance was read at wavelength 517 nm by using spectrophotometer UV-Vis Hewlett Packard 8435. Methanol was used as a blank and DPPH solution 50 μg/mL as standard. Analysis was done in triplicate for standard and each extract. Antioxidant activity of each extract were determined based on the reduction of DPPH absorbance by calculating percentage of antioxidant activity (Bedawey, 2010; Molyneux, 2003).

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 solution 7.6 mM in ethanol and potassium persulfate solution 2,5 mM in ethanol were prepared. Each solutions allowing to stand in the dark room for 12 hours. The two solutions were mixed with 30-60 minutes incubation, then diluted in ethanol. Each extract 50 μg/mL was pipetted into ABTS solution 50 μg/mL (1:1) to initiate the reaction. The absorbance was read at wavelength 734 nm without incubation time using spectrophotometer UV-Vis Hewlett Packard 8435. 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 extract. Antioxidant capacity of each extract were determined based on the reduction of ABTS absorbance by calculating percentage of antioxidant activity (Bedawey, 2010).

Total phenolic determination

Total phenolic content was measured using the modified Folin-Ciolcalteu method adapted from Pourmorad (2006). The absorbance was read at wavelength 765 nm. Analysis was done in triplicate for each extract. 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 flavonoid determination

Total flavonoid content was measured using adapted method from Chang *et al* (2002). The absorbance was read at wavelength 415 nm. Analysis was done in triplicate for each extract. Standard solutions of quercetin with concentration 40-160 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 carotenoid determination

Total carotenoid content was measured using the modified carotene method adapted from Thaipong *et al* (2006). Each extract was diluted in acetone. The absorbance was read at wavelength 470 nm. Analysis was done in triplicate for each extract. Standard solutions of beta carotene with concentration 10-40 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).

Statistic

Each sample analysis was performed in triplicate. All results presented were the 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 16.0 for Windows. Correlations between the total phenolic, flavonoid and total carotenoid content and antioxidant capacities were made using the Pearson method ($p < 0.01$).

RESULTS AND DISCUSSION

Both of DPPH and ABTS are stable free radicals which dissolve in methanol or ethanol, and their colors show characteristic absorption at wavelength 734 nm or 516 nm, respectively. Colors DPPH and ABTS would be changed when the free radicals were scavenged by antioxidant (Apak, 2007; Li, 2011). Some of tropical plants including dragon fruit peels had antioxidant capacity using various antioxidant testing assays (Adnan, 2011; Ling, 1999; Nurliyana, 2010; Souri, 2008; Thaipong, 2006).

Nurliyana (2010) revealed that DPPH scavenging activity of ethanolic peels extract of *H. undatus* was higher than ethanolic peels extract of *H. polyrhizu.* Previous study (Choo, 2011) demonstrated that IC_{50} of DPPH scavenging capacities of aqueous pulps extract of *H. polyrhizus* similar with *H. undatus.* There was no study regarding antioxidant capacity of three various extracts (which were n-hexane, ethyl acetate and ethanol) of dragon fruit peels using DPPH and ABTS assays and also analyze their correlation with total phenolic, flavonoid and carotenoid content.

Antioxidant capacities of various peels extracts from three kinds dragon fruit using DPPH and ABTS assays

The antioxidant capacities using DPPH and ABTS assays of various peels extracts from three dragon fruit peels were shown in Table 1, Table 2, Table 3. In the present study, antioxidant capacities by DPPH method in the range of 46.51 – 53.87 %. WH2 peels extract (ethyl acetate extract of white dragon fruit) had the highest DPPH radical scavenging capacity (53.87 %), followed

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

Sample	DPPH scavenging capacity (%)	ABTS capacity (%)
HB1	50.14 ± 1.16 a	55.93 ± 0.43 a
SR1	46.51 ± 4.72 a	56.09 ± 0.83 a
WH1	52.73 ± 0.11 a	65.01 ± 1.12 b
Ascorbic acid	98.49 ± 0.33	99.27 ± 0.03
P value	< 0.05	< 0.05

Note: a –c = means within a column with the same letter were not significantly different (p=0.05)

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

Sample	DPPH scavenging capacity (%)	ABTS capacity (%)
HB2	51.34 ± 0.23 a	60.15 ± 1.21 a
SR2	53.58 ± 0.50 b	68.96 ± 1.75 b
WH2	53.87 ± 0.08 b	72.47 ± 2.05 b
Ascorbic acid	98.49 ± 0.33	99.27 ± 0.03
P value	< 0.05	< 0.05

Note: a –c = means within a column with the same letter were not significantly different (p=0.05)

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

Sample	DPPH scavenging capacity (%)	ABTS capacity (%)
HB3	52,15 ± 0,28 a	62,37 ± 4,24 a
SR3	50,84 ± 0,18 b	58,80 ± 0,82 a
WH3	52,27 ± 0,59 a	59,59 ± 0,58 a
Ascorbic acid	98.49 ± 0.33	99.27 ± 0.03
P value	< 0.05	< 0.05

Note: a –c = means within a column with the same letter were not significantly different (p=0.05)

by sample SR2 (ethyl acetate peels extract of super red dragon fruit) and WH1 (n-hexane peels extract of white dragon fruit), while the lowest antioxidant capacity (46.51 %) was given by SR1 peels extract (n-hexane extract of super red dragon fruit).

Ethanolic peels extract of hybrid dragon fruit (HB3), super red dragon fruit (SR3) and white dragon fruit (WH3) had DPPH scavenging capacity 52.15 %, 50.84 % and 52.27 % respectively. The previous research by Adnan (2011) exposed that ethanolic seed extract of red dragon fruit (*Hylocereus polyrhizus*) gave higher DPPH scavenging capacity (70 %) than chloroform extract (20 %) dan n-hexana extract (20 %). Study by Nurliyana (2010) revealed that DPPH scavenging activity of ethanolic peels extract of *H. undatus* (85 %) was higher than ethanolic peels extract of *H. polyrhizus* (80 %), ethanolic pulps extract of *H. polyrhizus* (25 %) and ethanolic pulps extract of *H. undatus* (15 %).

In the ABTS method, free radical scavenging capacities of various peels extracts from dragon fruit peels ranged from 55.93 – 72.47 %. WH2 (ethyl acetate extract of white dragon fruit) had the highest ABTS capacity (72.47%), while HB1 (n-hexane extract of hybrid dragon fruit peels extract) 55.93% had the lowest ABTS capacity. The highest ABTS scavenging capacitiy was given by WH2 (ethyl acetate peels extract of white dragon fruit), followed by SR2 (ethyl acetate peels extract of super red dragon fruit) and WH1 (n-hexane peels extract of white dragon fruit).

IC_{50} of DPPH scavenging capacity and IC_{50} of ABTS scavenging activity

The IC_{50} of DPPH scavenging capacities and IC_{50} of ABTS scavenging activities in various extracts from dragon fruit peels using DPPH and ABTS assays were shown in Fig 1 and Fig 2. Both of IC_{50} of DPPH scavenging capacities and IC_{50} of ABTS scavenging activities of each extracts were compared to ascorbic acid as standard. The lowest IC50 means had the highest antioxidant capacity. Concentration of sample that could scavenge 50 % free radical (IC_{50}) was used to determine antioxidant capacity of sample compared to standard. The lowest IC50 means had the highest antioxidant capacity. Sample that had IC_{50} < 50 ppm, it was very strong antioxidant, 50-100 ppm strong antioxidant, 101-150 ppm medium antioxidant, while weak antioxidant with IC_{50} > 150 ppm (Blois, 1958).

WH2 (ethyl acetate peels extract of white dragon fruit) had the lowest IC_{50} of DPPH scavenging activity (0.71 ppm), while ascorbic acid standard gave IC_{50} of DPPH scavenging capacity 1.45 ppm. All of extracts of dragon fruit peels (hybrid, super red and white) had the IC_{50} of DPPH scavenging capacities in the range of 0.71 – 53.67 ppm. Based on classification of antioxidant potency by Blois (1958), all of dragon fruit peels extracts sample (except n-hexane peels extract of hybrid dragon fruit with IC_{50} 53.67 ppm) can be classified as very strong antioxidant. In the present study expressed that ethanolic peels extract of HB3 (hybrid dragon fruit), SR3 (super red dragon fruit) and WH3 (white dragon

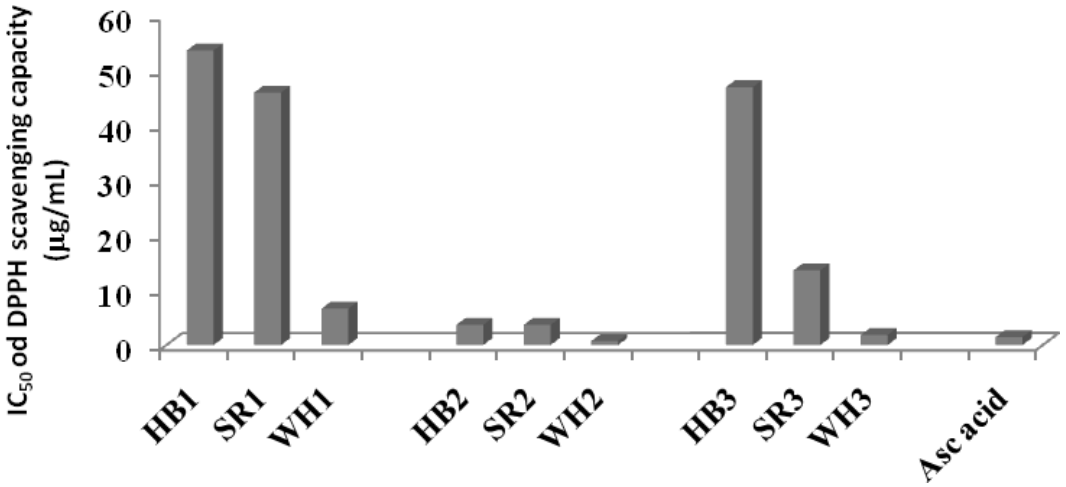

Figure 1: IC50 of DPPH scavenging capacities in various dragon fruit peels extracts

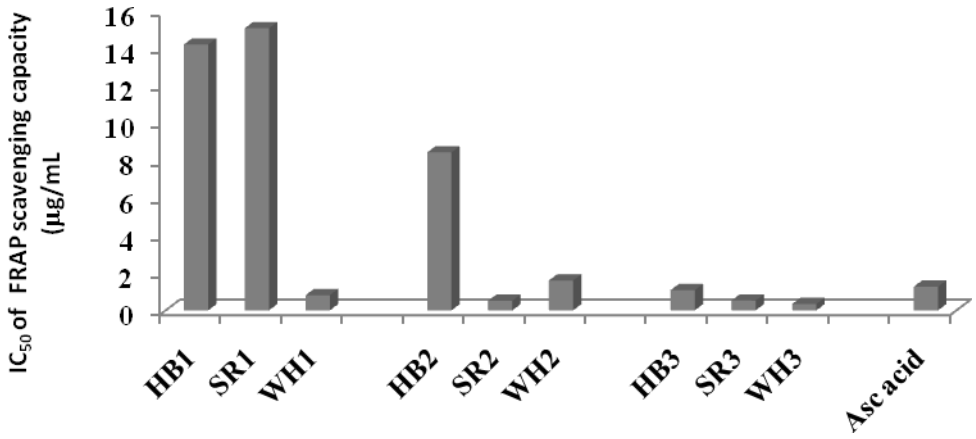

Figure 2: IC50 of ABTS scavenging activities in various dragon fruit peels extracts

fruit) had IC_{50} of DPPH scavenging capacities was 47 ppm, 13.59 ppm and 1.83 ppm. The previous study (Choo, 2011) demonstrated that IC_{50} of DPPH scavenging capacities of aqueous pulps extract of *H. polyrhizus* and *H. undatus* were 9.93 mg/mL and 9.91 mg/mL respectively, while IC_{50} of DPPH the aqueous fruits extract of *H. polyrhizus* and *H. undatus* were 11.34 mg/mL and 14.61 mg/mL respectively. Luo (2014) exposed that supercritical carbon dioxide peels extract of *H. polyrhizus* and *H. undatus* had IC_{50} of DPPH scavenging capacity 0.83 mg/mL and 0.91 mg/mL respectively. The previous study (Rebecca, 2010) showed that ethanolic fruits extract of *H. polyrhizus* had IC_{50} of DPPH scavenging capacity 2.90 mM vitamin C/g extract.

Various extracts from dragon fruit peels had IC_{50} of ABTS scavenging activities ranged from 0.34 to 15.11 ppm. Base on classification Blois (1958) its can be classified as very strong antioxidant. WH3 (ethanolic peels extract of white dragon fruit) had the lowest IC_{50} of ABTS capacity 0.34 ppm, while ascorbic acid standard gave IC_{50} of ABTS scavenging capacity 1.27 ppm and its exposed that antioxidant capacity of WH3 had four times potency of ascorbic acid using ABTS method.

Total phenolic in various dragon fruit peels extracts

The total phenolic content among the various extracts were expressed in term of gallic acid equivalent using the standard curve equation y = 0.0044 x + 0.031, R^2 = 0.993. The total phenolic content in various extracts from dragon fruit peels showed different result ranged from 1.55 to 4.55 g GAE/100 g. SR2 peels extract (ethyl acetate peels extract of super red dragon fruit) had the highest phenolic content (4.55 g GAE/100 g) (Fig 3).

The presence of total phenolic might contribute to antioxidant activity (Ling, 1999). Phenolic acid might contributed in antioxidant activity. Phenyl acetic acid and benzoic acid had lower antioxidant capacity than cinnamic acid (Heim, 2002). In present study total phenolic of ethanolic peels extract of hybrid dragon fruit, super red dragon fruit and white dragon fruit were 1.55 g GAE/100 g, 4.58 g GAE/100 g and 1.98 g GAE/100 g respectively. Research by Nurliyana (2010) which exposed that total phenolic in ethanolic peels extract of *H. undatus* and *H. polyrhizus* were 36.12 mg/100 g and 28.16 mg/100 g, while ethanolic pulps extract of *H. undatus* and *H. polyrhizus* were 19.72 mg/100 g and 3.75 mg/100 g respectively. Previous study (Adnan, 2011) exposed that seed extract of *H. polyrhizus* had total phenolic 13.56 mg/g dry weight sample and (Rebecca, 2010) showed that ethanolic fruits extract of *H. polyrhizus* had contained 172.2 mg/g extract. Choo

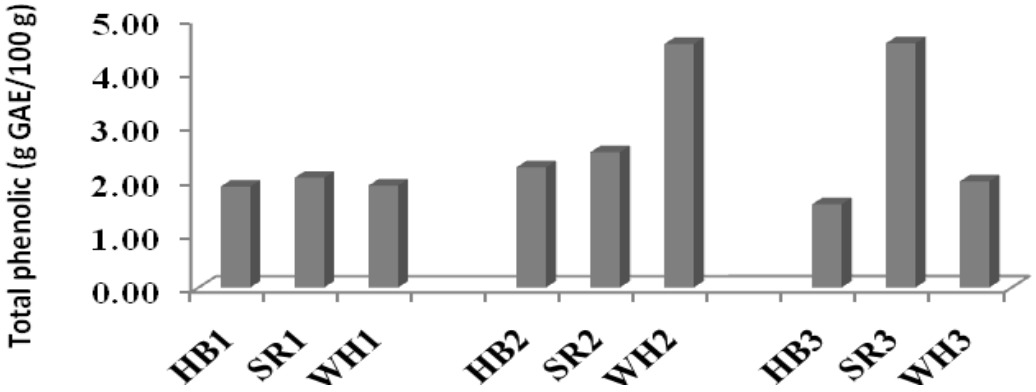

Figure 3: Total phenolic content in various dragon fruit peels extracts

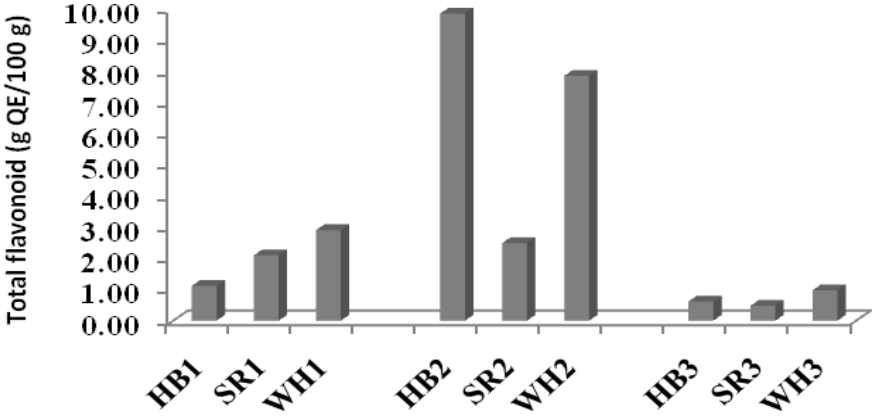

Figure 4: Total flavonoid content in various dragon fruit peels extracts

(2011) expressed that total phenolic content in aqueous fruits extract of hybrid dragon fruit (*H. polyrhizus*) and white dragon fruit *(H. undatus*) were 15.92 mg GAE/100 g and 20.14 mg GAE/100 g, while aqueous pulps extract of *H. polyrhizus* and *H. undatus* were 24.22 mg GAE/100 g and 28.65 mg GAE/100 g respectively.

Total flavonoid in various dragon fruit peels extracts

The total flavonoid content among the various extracts were expressed in term of quercetin equivalent using the standard curve equation y = 0.00761355x + 0.00491857, R^2= 0.998. The total flavonoid content in various extracts from dragon fruit peels showed different result in the range of 0.48 – 9.85 g QE/100 g (Fig 4). HB2 (ethyl acetate peels extract of hybrid dragon fruit) had the highest total flavonoid content (9.85 g QE/100 g) and the lowest (0.48 g QE/100 g) for SR3 peels extract.

Total flavonoid of ethanolic extract in the present study exposed that white dragon fruit peels had the highest total flavonoid (0.98 g QE/100 g) compared to hybrid dragon fruit (0.61 g QE/100 g) and super red dragon fruit (0.48 g QE/100 g). The previous study (Adnan, 2011) demonstrated that seed extract of hybrid dragon fruit (*H. polyrhizus*) contained the two major compound of flavonoid group were catechin 3.60 mg/g and qurcetin 1.31 mg/g dry weight. Study by Rebecca (2010) showed ethanolic fruits extract of *H. polyrhizus* had total flavonoid 2.3 mg catechin/g. Phenolic acid had the lower antioxidant capacity than flavonoid (Heim, 2010). Flavonoid would give higher antioxidant capacity if flavonoid had OH in ortho C 3',4', OH in C3, oxo function in C4, double bond at C2 and C3. The OH with ortho position in C3'-C4' had the highest influence to antioxidant capacity of flavonoid. The flavonoid glycosides would give lower antioxidant capacity than flavonoid aglycones (Heim, 2002). Fig 3 showed that total flavonoid in HB2 (ethyl acetate peels extracts of hybrid dragon fruit) was higher (9.85 g QE/100 g) than WH3 (0.98 g QE/100 g), but DPPH scavenging capacities of HB2 (51.34 %) was similar with WH3 extracts (52.27 %). Based on this data it can predicted that many flavonoids in ethyl acetate peels extract of hybrid dragon fruit were flavonoid that had no OH in ortho C3',4', OH in C3, oxo function in C4, double bond at C2 and C3. In contrast it can demonstrated that WH3 extract contained many flavonoids which had high antioxidant effect.

Total carotenoid in various dragon fruit peels extracts

The total carotenoid content among the various extracts were expressed in term of beta carotene equivalent using the standard curve equation y = 0.02764x - 0.00324857, R^2 = 0.999. The total carotenoid content in various extracts from dragon fruit peels showed different result in the range of 0 – 1.51 g BET/100 g (Fig 5). The highest carotenoid content (1.51 g BET/100 g) for SR1 and WH1 peels extract, while the lowest carotenoid (0 g BET/100 g) for SR3 peels extract.

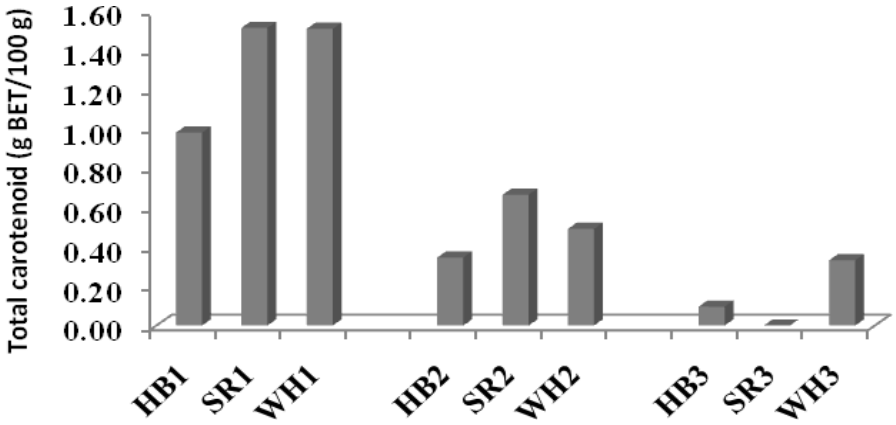

Figure 5: Total carotenoid content in various dragon fruit peels extracts

Table 4: Pearson's correlation coefficient of total flavonoid, phenolic, carotenoid in dragon fruit peels extracts and ABTS, DPPH scavenging activities

	Total Flavonoid	Total Phenolic	Total Carotenoid	DPPH HB	DPPH SR	DPPH WH
DPPH HB	0.041^{ns}	-0.179^{ns}	-0.812^{**}			
DPPH SR	0.613^{ns}	0.302^{ns}	-0.617^{ns}			
DPPH WH	0.894^{**}	0.855^{**}	0.037^{ns}			
ABTS HB	0.117^{ns}	-0.186^{ns}	-0.785^{*}	0.769*		
ABTS SR	0.949^{**}	0.711^{*}	-0.424^{ns}		-0.248^{ns}	
ABTS WH	0.905^{**}	0.866^{**}	0.180^{ns}			-0.312^{ns}

Note: DPPH = DPPH scavenging capacity, ABTS = ABTS scavenging capacity, HB = hybrid dragon fruit, SR = super red dragon fruit, WH = white dragon fruit, ns = not significant, * = significant at $p < 0.05$, ** = significant at $p < 0.01$.

Carotenoid with more double bonds would give higher scavenging free radical capacity (Foote, 1976). Carotenoid that consisted of maximum 7 double bonds gave lower scavenging radical free capacity than more double bonds (Beutner, 2000). In previous study by Kobayashi and Sakamoto (1999) revealed that increasing in lipophilicity of carotenoid would increase scavenging radical capacity. Beta carotene was used as standard because of it had conjugation double bonds doe to its ability to scavenge free radicals (Muller, 2011; Charles, 2013).

Fig 5 revealed that total carotenoid in SR1 peels extract (1.51 g BET/100 g) was higher than WH2 peels extracts (0.49 g BET/100 g), but DPPH scavenging activity of SR1 (46.51 %) lower than WH2 (53.87 %). It was similar with its ABTS scavenging activity, which SR1 (56.09 %) was lower than WH2 (72.47 %). Based on the above data, it could be seen that many carotenoids in ethyl acetate peels extract of white dragon fruit were higher than 7 double bonds, which had high antioxidant capacity.

Correlations between total flavonoid, phenolic, carotenoid content and ABTS, DPPH scavenging activities, in various dragon fruit peels extracts

Pearson's correlation coefficient was positively high if $0.68 \leq r \leq 0.97$ (Thaipong, 2006). The highly positive correlation between total phenolic content and DPPH scavenging activity ($r = 0.855$, $p<0.01$) and ABTS scavenging capacity ($r = 0.866$, $p<0.01$) was given by sample WH. The positive and high correlation between flavonoid content and DPPH scavenging activities ($r = 0.894$, $p<0.01$) and ABTS scavenging activity ($r = 0.905$, $p<0.01$) were given by sample WH also. (Table 4).

The data in Table 4 exposed that there was positively high correlation between total phenolic and total flavonoid content in white dragon fruit peels sample and antioxidant capacities using DPPH and ABTS assays. Total phenolic content in white dragon fruit had high and positive correlation with DPPH scavenging capacity that were $r = 0.855$, $p<0.01$ and ABTS scavenging activity $r = 0.866$, $p<0.01$. DPPH and ABTS scavenging capacity of white dragon fruit peels extract had high correlation with its total flavonoid content that were $r = 0.894$, $p<0.01$ and $r = 0.905$, $p<0.01$ respectively. Based on this data it could be concluded that antioxidant capacities in white dragon fruit peels sample by DPPH and ABTS methods might be estimated indirectly by determining their total phenolic and total flavonoid content.

Total phenolic content and total flavonoid in super red dragon fruit (*H. costaricensis*) peels extract had positively high correlation with its ABTS scavenging capacity, $r = 0.711$, $p<0.05$ and $r = 0.949$, $p<0.01$ respectively. It can be concluded that antioxidant capacity of super red dragon fruit peels extract by ABTS method can be

estimated indirectly by determining its total phenolic and total flavonoid content.

Total carotenoid content in white dragon fruit had negative correlation with DPPH ($r = -0.812$, $p<0.01$) and ABTS scavenging activities ($r = -0.785$, $p<0.05$). Based on this data it could be concluded that carotenoids compund in white dragon fruit peels were not major compound for DPPH and ABTS scavenging capacities.

DPPH and ABTS methods had the same mechanism reaction that was electron transfer assays (Huang, 2005), but the results of the present study showed that ABTS scavenging capacity not always linear with DPPH scavenging activity. The Pearson's correlation coefficient of various extracts from dragon fruit peels sample indicated that DPPH scavenging capacities of hybrid dragon fruit had positive and high correlation with their ABTS scavenging activities. It could be seen that antioxidant capacities in hybrid dragon fruit peels sample by DPPH assays were linear with ABTS assays.

CONCLUSION

To assess the antioxidant capacity of sample, variety of methods must be used in parallel, because different methods often give different results. All of dragon fruit peels extracts sample (except n-hexane peels extract of hybride dragon fruit) can be classified as very strong antioxidant. Total phenolic and total flavonoid content in white dragon fruit peels sample had positively high correlation with DPPH and ABTS scavenging activities. Antioxidant capacity by DPPH and ABTS assays in white dragon fruit peels sample might be estimated indirectly by using total phenolic and total flavonoid content. Phenolic and flavonoid compounds were the major contributor in antioxidant capacity in white dragon fruit peels sample. DPPH scavenging capacities of hybrid dragon fruit peels extract gave linear correlation with ABTS scavenging activities. All of sample (hybrid, super red and white dragon fruit) peels extract may be exploited as a source of natural antioxidant which could be beneficial for consumers and the pharmaceuticals industry.

REFERENCES

Adnan L, Osman A, Hamid AA. Antioxidant Activity of Different Extracts of Red Pitaya (*Hylocereus polyrhizus*) Seed, Int J Food Properties 2011; 14: 1171–1181.

Agbor GA, Moumbegna P, Oluwasola EO, Nwosu LU, Njoku RCC, Kanu S, Emekabasi EI, Akin F, Obasi AP, Abudei FA. Antioxidant capacity of some plant foods and beverages consumed in the eastern region of Nigeria, Afr J Tradit Complement Altern Med. 2011; 8(4): 362–369.

Apak R, Kubilay G, Birsen D, Mustava O, Saliha EC, Burcu B. 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 plant's sources, Cairo: Shibin El-Kom; 2010, p. 1-11.

Beutner S, Bloedorn B, Hoffmann T, Martin HD. Synthetic singlet oxygen quenchers, Methods Enzymol. 2000; 319: 226-241.

Blois MS. Antioxidant determination by the use of stable free radicals, Nature 1958; 181: 1199-2000.

Chang CC, Yang MH, Wen HM, Chern JC. Estimation of total flavonoid content in propolis by two complementary colorimetric methods, J Food Drug Anal. 2002; 10: 178-182.

Charles DJ. Antioxidant properties of spices herbs and other. London: John Willey; 2013.

Choo WS, Yong WK, Antioxidant properties of two species of *Hylocereu*s fruits, Adv Appl Sci Res. 2011; 2 (3): 418-425.

Foote, CS. Free radicals in biology. 3rd ed. New York: Academic Press; 1976.

Heim KE, Tagliaferro AR, Bobilya DJ. Flavonoid antioxidants: Chemistry, metabolism and structure-activity relationships, J Nutr Biochem. 2002; 13: 572 -584.

Huang D, Ou B, Prior RL. The chemistry behind antioxidant capacity assays, J Agric Food Chem. 2005; 53: 1841 -1856.

Huang WY, Zhang HC, Liu WX, and Li CY. Survey of antioxidant capacity and phenolic composition of blueberry, blackberry, and strawberry in Nanjing, J Zhejiang Univ Sci B. 2012; 13(2): 94–102

Jain N, Goyal S, Ramawat KG. Evaluation of antioxidant properties and total phenolic content of medicinal plants used in diet therapy during postpartum healthcare in Rajasthan, Int J Pharm Pharm Sci. 2011; 3(3): 248-253.

Kobayashi M, Sakamoto Y. Singlet oxygen quenching ability of astaxanthin esters from the green alga *Haematococcus pluvialis*, Biotech Lett. 1999; 21: 265-269.

Li XC, Wang XZ, Chen DF, Chen SZ. Antioxidant activity and mechanism of protochatechuic acid in vitro, J Funct Food Health Dis. 2011; 1: 232-244.

Ling, LT and Palanisamy, UD. Review: Potential antioxidants from tropical plants, In: Valdez, B., editor, Food industrial processes-methods, Kuala Lumpur: In Tech; 1999. p. 64-72.

Luis A, Gil N, Amaral ME, Duarte AP. Antioxidant activities of extract from *Acacia melanoxylon, Acacia dealbata, Olea europaea* and alkaloids estimation, Int J Pharm Pharm Sci. 2012; 4: 225-231.

Luo H, Cai Y, Peng Z, Liu T, Yang SS. Chemical composition and *in vitro* evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide ex- tracts of pitaya (dragon fruit) peel, Chem Cent J. 2014; 8: 1-11.

Mallick C, Chatterjee K, Biswas MG, Ghosh D. Antihyperglycemic Effects of separate and composite extract of root of *Musa paradisiaca* and Leaf of *Coccinia indica* in Streptozotocin-induced diabetic male albino rat, Afr J Tradit Complement Altern Med. 2007; 4(3): 362–371.

Molyneux, P. *The Use of Stable Free Radical Diphenylpicrylhydrazyl (DPPH) for Estimating Antioxidant Activity,* J Sci Tech. 2003; 26 (2): 211-219.

Müller L, Fröhlich K, Böhm V. Comparative antioxidant activities of carotenoids measured by ferric reducing antioxidant power (FRAP), ABTS bleaching assay (aTEAC), DPPH assay and peroxyl radical scavenging assay, Food Chem. 2011; 129: 139-148

Nurliyana R., Zahir, SI., Suleiman MK., Aisyah, MR., Rahim, KK. Antioxidant study of pulps and peels of dragon fruits: a comparative study, Int Food Res J. 2010; 17: 367-375

Pellegrini N, Serafini M, Colombi B, Rio DD, Salvatore S. 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. 2006; 5(11): 1142-1145.

Rebecca OPS, Boyce AN, Chandran S. Pigment identification and antioxidant properties of red dragon fruit (*Hylocereus polyrhizus*), Afr J Biotechnol. 2010; 9(10), 1450-1454.

Souri E, Amin G, Farsan H, Barazandeh TM. Screening antioxidant activity and phenolic content of 24 medicinal plants extracts, DARU J Pharm Sci. 2008; 16: 83 -87

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