Running title: antioxidant properties and total phenolic contents of wetland medicinal plants in Taiwan

In vitro antioxidant properties and total phenolic contents of wetland medicinal plants in Taiwan

Yu-Ling HO[1], Shyh-Shyun HUANG[1], Jeng-Shyan DENG[2], Yaw-Huei LIN[3], Yuan-Shiun CHANG[4], Guan-Jhong HUANG[4,] *

[1] *Department of Nursing, Hung Kuang University, Sha Lu, Taichung 433, Taiwan*

[2]*Department of Health and Nutrition Biotechnology, Asia University, Taichung 413, Taiwan*

[3]*Institute of Plant and Microbial Biology, Academia Sinica, Taipei 115, Taiwan*

[4]*School of Chinese Pharmaceutical Sciences and Chinese Medicine Resources, China Medical University, Taichung 404, Taiwan*

*Corresponding author:

Dr. Guan-Jhong HUANG

School of Chinese Pharmaceutical Sciences and Chinese Medicine Resources, China Medical University, 91, Hsueh-Shih Road, Taichung 404, Taiwan

Tel.: +886-4-22053366 ext 5508; Fax: +886-4-22083362

E-mail: gjhuang@mail.cmu.edu.tw

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ABSTRACT. The aim of this study was to examine the possible antioxidant activities of the methanol and water extracts of 31 medicinal wetland plants in Taiwan. A number of assays were employed in this experiment to investigate the antioxidant effects of wetland medicinal plants in Taiwan, including TEAC assay, DPPH radical scavenging, reducing power method, total polyphenol content, total flavonoid content and total flavonol contents. The results showed that *Rotala rotundifolia* (Wallich ex Roxb.) Koehne, *Juncus effusus* L. var. *decipiens* Buchen., *Cyperus iria* L., *Salix warburgii* O. Seem., *Lindernia antipoda* (L.) Alston, *Kyllinga brevifolia* Rottb., and *Typha orientalis* Presl possessed high antioxidant activities and high contents of total polyphenols. The lower correlations between TEAC and total polyphenol content (water extracts, R^2=0.14; methanol extracts, R^2=0.23) was found. Therefore, high phenolic content was not an important factor in determining antioxidant capacities of these wetland medicinal plants. The results demonstrated that phytochemicals in the wetland medicinal plants might contribute significantly to the antioxidant activities of the wetland medicinal plants; however the antioxidant activities were not directly related to the quantity of polyphenols. Phytochemicals might have additive roles that contribute significantly to the potent antioxidant activity of wetland medicinal plants. It indicated that wetland medicinal plants could be used as an easy accessible source of natural antioxidants in pharmaceutical and medical industries, as well as being developed into health foods.

Keywords: Wetland medicinal plant；Antioxidant；Polyphenol；Flavonoid; Flavonol.

INTRODUCTION

It is commonly accepted that under situations of oxidative stress, reactive oxygen species, such as superoxide ($O_2^{\cdot-}$), hydroxyl ($OH^{\cdot}$), and peroxyl ($^{\cdot}OOH$, $ROO^{\cdot}$) radicals, are generated. These reactive oxygen species play important roles in degenerative or pathological processes, such as aging (Burns et al., 2001), cancer, coronary heart disease, Alzheimer's disease (Diaz et al., 1997), neurodegenerative disorders, atherosclerosis, diabetes, and inflammation (Chen et al., 2006). Several anti-inflammatory, digestive, anti-necrotic, neuroprotective, and hepatoprotective drugs have been shown recently to have antioxidant and/or radical scavenging mechanism as part of their activity (Lin and Huang, 2002). In searching for specific natural antioxidants and compounds with radical scavenging activity during the last few years, some had been identified, such as echinacoside in *Echinaceae* root (Hu and Kitts, 2000), anthocyanin (Espin et al., 2000), phenolic compounds (Rice-Evans et al., 1997), and the extracts of water spinach and sweet potato tuberous roots (Huang et al., 2004; Huang et al., 2005).

Medicinal plant parts are commonly rich in phenolic compounds, such as flavonoids, phenolic acids, stilbenes, tannins, coumarins, lignans and lignins. They have multiple biological effects including antioxidant activity (Packer et al., 1999). The antioxidant compounds of higher plants have been demonstrated, *in vitro* experiments, to protect against oxidation damage by inhibiting or quenching free radicals and reactive oxygen species (Ali et al., 2008). The roles of these compounds as potential antioxidants can be inferred by their similarity to synthetic antioxidants, of related structures.

The multifarious natural environment of Taiwan harbors abundant plant resources. However, many species still face endangerment. Therefore, we investigated wetland medicinal plants and analyzed their antioxidant activities. In the present study, we collected 31 medicinal wetland plant species that are widely consumed in Taiwan, and analyzed the antioxidant activities and polyphenol contents of water and methanolic extracts prepared from these plants.

MATERIALS AND METHODS

Materials

Butylated hydroxytoluene (BHT), Glutathione (GSH), 1,1-Diphenyl-2-picrylhydrazyl (DPPH), 6-Hydroxy-2, 5, 7, 8-tetramethylchroman-2-carboxylic acid (Trolox), potassium peroxodisulfate ($K_2S_2O_8$), Tris (hydroxylmethyl) aminomethane, potassium ferricyanide ($K_3Fe(CN)_6$), ferric chloride ($FeCl_3$), catechin, 2,2'-azinobis-(3-ethylbenzothiazoline)-6-sulphonic acid (ABTS), and other chemicals were purchased from Sigma Chemical Co. (St. Louis, MO, USA). Folin-Ciocalteu solution and 95% ethanol were purchased from Merck Co. (Santa Ana, CA, USA). Thirty one wetland medicinal plants were collected from Taichung, Nantou, and Hsinchu counties in Taiwan. They were identified and authenticated by Dr. Chao-Lin Kuo, Associate professor and Chairman, Department of Chinese Medicine Resources, China Medical University, Taichung, Taiwan. The medicinal wetland plants studied were all described in the Catalogue of Medicinal Plant Resources in Taiwan which was published by Committee on Chinese Medicine and Pharmacy, Department of Health, Taiwan (Lin 2003).

Preparation of the methanol extracts of plant materials

Dried whole herbs (100 g for each sample) were macerated with 1L 95% ethanol for 24 hours at room temperature. Filtration and collection of the extract were done three times. Then the ethanol extract (3 L) was evaporated to 10 mL and dried in vacuum at 40℃. The dried extract was weighted and dissolved in 95% ethanol and stored in -20℃ for further use.

Preparation of the water extracts of plant materials

Dried whole herbs (100 g for each sample) were boiled with 1L distilled water for 1 hour. Filtration and collection of the extracts were done three times. The resulting decoction was evaporated to 10 mL and dried in vacuum at 50℃. The dried extract was weighted and dissolved in distilled water and stored in -20℃ for further use. For each extract, the yield was calculated in percentage on the basis of the dry weight of the whole herbs used (100 g) and the quantity of dry mass obtained after extraction (*w/w*).

Determination of antioxidant activity by TEAC assay

The TEAC assay was determined according to the method of Ramos et al. (1999). Aqueous solution of ABTS (7 mM) was oxidized with potassium peroxodisulfate (2.45 mM) for 16 hours in the dark at room temperature. The $ABTS^{\cdot+}$ solution was diluted with 95% ethanol to an absorbance of 0.75 ± 0.05 at 734 nm (Beckman UV-Vis spectrophotometer, Model DU640B). An aliquot (20 µL) of each sample (125 µg/mL) was mixed with 180 µL $ABTS^{\cdot+}$ solution and the absorbance was read at 734

nm after 1 min. Trolox was used as a reference standard. A standard curve was constructed for Trolox at 0, 15.625, 31.25, 62.5, 125, 250, 500 μM concentrations. TEAC value was expressed as millimolar concentration of Trolox solution with the antioxidant equivalent to a 1000 ppm solution of the sample under investigation.

Determination of antioxidant activity by DPPH radical scavenging ability

The effects of crude extracts and positive controls (GSH and BHT) on DPPH radicals were estimated according to the method of Yamaguchi et al. (1998). Aliquot (20 μL) of crude extracts at various concentrations were each mixed with 100 mM Tris-HCl buffer (80 μL, pH 7.4) and then with 100 μL of DPPH in ethanol to a final concentration of 250 μM. The mixture was shaken vigorously and left to stand at room temperature for 20 min in the dark. The absorbance of the reaction solution was measured spectrophotometrically at 517 nm. The percentage of DPPH decolorization of the samples was calculated according to the equation: % decolorization = [1- (ABS_{sample} /$ABS_{control}$)] ×100. IC_{50} value was the effective concentration at which DPPH radicals were scavenged by 50% and was obtained by interpolation from linear regression analysis. A lower IC_{50} value indicated a greater antioxidant activity.

Measurement of reducing power

The reducing power of the crude extracts and positive controls (GSH and BHT) were determined according to the method of Yen and Chen (1995). The samples (0, 31.25, 62.5, 125, 250, 500, and 1000 μg/mL) were each mixed with an equal volume of 0.2 M phosphate buffer, pH 6.6, and 1% potassium ferricyanide. The mixture was incubated at 50℃ for 20 min before an equal volume of 1% TCA was added, and then centrifuged at 5,000 g for 10 min. The upper layer of the solution was mixed with

distilled water and 0.1% $FeCl_3$ with a ratio of 1: 1: 2, and the absorbance was measured at 700 nm. Increased absorbance of the reaction mixture indicated an increase in reducing power.

Determination of total polyphenol content

The total polyphenol contents of the crude extracts were determined according to the method of Ragazzi and Veronese (1973). 20 μL of each extract (125 μg/mL) was added to 200 μL distilled water and 40 μL of Folin-Ciocalteu reagent. The mixture was allowed to stand at room temperature for 5 min and then 40 μL of 20 % sodium carbonate was added to the mixture. The resulting blue complex was then measured at 680 nm. Catechin was used as a standard for the calibration curve. The polyphenol content was calibrated using the linear equation based on the calibration curve. The total polyphenol content was expressed as mg catechin equivalent/g dry weight. The dry weight indicated was the sample dry weight.

Determination of total flavonoid content

The total flavonoid contents of the crude extracts were determined according to the method of Lamaison and Carnet (1990). Aliquots of 1.5 mL extracts were each added to an equal volume of 2% $AlCl_3 \cdot 6H_2O$ (2g in 100 mL methanol) solution. The mixture was vigorously shaken, and the absorbance was read after 10 min of incubation at 430 nm. Rutin was used as the standard for the calibration curve. The total flavonoid content was calibrated using the linear equation based on the calibration curve. The total flavonoid content was expressed as mg rutin equivalent/g dry weight. The dry weight indicated was the sample dry weight.

Determination of total flavonol content

The total flavonol contents of the crude extracts were determined according to the method of Arnous et al. (2001). Aliquots of 200 μL extracts were each added to 1 mL of 0.1% *p*-dimethylaminocinnamaldehyde (DMACA) in methanol/HCl (3:1, v/v). The mixture was vigorously shaken, and the absorbance was read after 10 min of incubation at 640 nm. Catechin was used as the standard for the calibration curve. The total flavonol content was calibrated using the linear equation based on the calibration curve. The total flavonol content was expressed as mg catechin equivalent/g dry weight. The dry weight indicated was the sample dry weight.

Statistical analysis

Experimental results were presented as the mean ± standard deviation (SD) of three parallel measurements. Statistical analyses were performed by one-way ANOVA, followed by Dunnett's *t* test. The difference was considered to be statistically significant when the *p* value was less than 0.05.

RESULTS

Extraction yields

The yields of water and methanol extracts of the wetland medicinal plants are presented in Table 1. The yield of water extracts ranged from 4.24 % to 70.18 %, and the yield of methanol extracts ranged from 0.89 % to 34.03 %. For the water extracts, *Pistia stratiotes* L. had the highest yield (70.18 %), followed by *Lindernia antipoda* (L.) Alston. (63.33 %), *Polygonum plebeium* R. Br. (45.99 %), *Alisma orientalis* (Sam.) Juzep. (43.33 %), and *Torulinium odoratum* (L.) S. Hooper (39.83 %). For the methanol extracts, the highest yield was obtained from *Lindernia antipoda* (L.) Alston

(34.03%), followed by *Cyperus alternifolius* L. subsp. *flabelliformis* (Rottb.) Kukenthal (26.76 %), *Avicennia marina* (Forsk.) Vierh.-root (24.37 %), *Pistia stratiotes* L. (21.58 %) and *Cyperus difformis* L. (17.84 %).

The yields of water and methanol extracts obtained from the wetland medicinal plants. The amount of components extracted by water generally was higher as compared to that extracted by methanol. It is worthy to notice that water extract may be allow more extracts to form hydrogen bonds with phenolic compounds than the methanol extract from the wetland medicinal plants.

Antioxidant activity estimated by TEAC assay

Trolox equivalent antioxidant capacity (TEAC) assay is often used to evaluate the total antioxidant power of single compounds and complex mixtures of various plants (Chang et al., 2007a, b). In this assay, ABTS radical monocation was generated directly in stable form from potassium peroxodisulfate. The radicals were generated before the addition of antioxidants to prevent interference of compounds, which affected radical formation. This modification made the assay less susceptible to interruptions and prevented overestimation of antioxidant power (Sanchez-Moreno, 2002). The tested samples were not added to the reaction medium until the stable absorbance was obtained, then their antioxidant activities were measured in terms of decolorization. It is recommended to be used for plant extracts because the maximum wavelength absorption of ABTS at 734 nm eliminates color interference in plant extracts (Awika et al., 2003). The results were expressed as μM Trolox/mg dry weight of plant material.

In the TEAC assay, the antioxidant capacities of wetland medicinal plants ranged

from 7.52 μM to 1753.41 μM Trolox/mg for the water extracts, and 5.69 μM to 2074.35 μM Trolox/mg for the methanol extracts (Table 2). The differences of antioxidant capacities were very large, up to 233 and 364 fold respectively. Among the different water extracts, *Rotala rotundifolia* (Wallich *ex* Roxb.) Koehne possessed the highest antioxidant capacity (1753.41 ± 76.99 μM Trolox/mg), followed by *Juncus effusus* L. var. *decipiens* Buchen. (971.14 ± 49.68 μM Trolox/mg), *Cyperus iria* L. (762.04 ± 33.80 μM Trolox/mg), *Salix warburgii* O. Seem. (657.57 ± 18.37 μM Trolox/mg) and *Kyllinga brevifolia* Rottb. (462.67 ± 9.49 μM Trolox/mg). For the methanol extracts, *Juncus effusus* L. var. *decipiens* Buchen. held the highest antioxidant capacity (2074.35 ± 116.19 μM Trolox/mg), followed by *Salix warburgii* O. Seem. (931.45 ± 84.14 μM Trolox/mg), *Cyperus iria* L. (769.41 ± 53.57 μM Trolox/mg), *Typha orientalis* Presl (651.22 ± 14.95 μM Trolox/mg) and *Kyllinga brevifolia* Rottb. (342.52 ± 10.91 μM Trolox/mg).

Scavenging activity against 1,1-diphenyl-2-picrylhydrazyl radicals

The relatively stable organic radical DPPH is widely used in modeling systems to investigate the scavenging activities of several natural compounds, such as phenolics and anthocyanins, as well as crude mixtures, such as methanol or water extract of plants. DPPH radical is scavenged by antioxidants through the donation of electrons forming the reduced DPPH. The color changes from purple to yellow after reduction, and the accompanying decrease in absorbance can be quantified at wavelength 517 nm. Table 3 shows the IC_{50} values for radical-scavenging activities of GSH, BHT and different extract fractions of the wetland medicinal plants using the DPPH colorimetric method.

In the DPPH assay conducted on the water extracts, it was found that *Rotala*

rotundifolia (Wallich *ex* Roxb.) Koehne had the lowest IC_{50} value among the medicinal plants (94.89 ± 0.31 μg/mL), followed by *Salix warburgii* O. Seem. (112.69 ± 0.28 μg/mL), *Lindernia antipoda* (L.) Alston (189.14 ± 4.55 μg/mL), *Cyperus iria* L. (194.45 ± 0.32 μg/mL), *Avicennia marina* (Forsk.) Vierh.-leaf (271.71 ± 1.28 μg/mL), and *Polygonum plebeium* R. Br. (301.52 ± 4.62 μg/mL). The positive control glutathione (GSH) had an IC_{50} value of 71.77 ± 2.09 μg/mL.

As for the methanol extracts, *Salix warburgii* O. Seem. had the lowest IC_{50} value (59.58 ± 0.33 μg/mL), followed by *Juncus effusus* L. var. *decipiens* Buchen. (108.95 ± 4.47 μg/mL), *Lindernia antipoda* (L.) Alston (144.61 ± 2.53 μg/mL), *Cyperus iria* L. (167.18 ± 0.64 μg/mL), *Typha orientalis* Presl (208.01 ± 1.46 μg/mL), and *Cyperus imbricatus* Retz. (242.55 ± 3.11 μg/mL). The positive control BHT also had a low IC_{50} value (139.56 ± 2.96 μg/mL). The above IC_{50} values showed that *Salix warburgii* O. Seem. and *Juncus effusus* L. var. *decipiens* Buchen. demonstrated even higher radical scavenging activities than the positive control in the DPPH assay.

Measurement of reducing power

We investigated the reducing capacity of wetland medicinal plants by measuring Fe^{3+}-Fe^{2+} conversion. The reducing capacity of a compound may serve as an important indicator of its potential antioxidant activity (Meir et al., 1995). The antioxidant activities of putative antioxidants have been attributed to various mechanisms, such as prevention of chain initiation, binding of transition metal ion catalysts, decomposition of peroxides, prevention of continued proton abstraction, and radical scavenging (Diplock, 1997). The reducing power of different extract fractions from the wetland medicinal plants are shown in Table 4. Both reduced GSH and BHT were used as the positive controls.

For the reducing capacity of the water extracts, it was found that *Salix warburgii* O. Seem. had the highest reducing capacity value among the examined medicinal plants (1.64 ± 0.01, Δ700), followed by *Rotala rotundifolia* (Wallich *ex* Roxb.) Koehne (1.61 ± 0.05, Δ700), *Lindernia antipoda* (L.) Alston (1.60 ± 0.07, Δ700), *Cyperus iria* L. (1.56 ± 0.01, Δ700), *Polygonum plebeium* R. Br. (1.17 ± 0.03, Δ700), and *Avicennia marina* (Forsk.) Vierh.-leaf (1.11 ± 0.01, Δ700). The positive control glutathione (GSH) had a high reducing capacity activity of 1.80 ± 0.01, Δ700.

For the methanol extracts, *Salix warburgii* O. Seem. had the highest reducing capacity value (1.68 ± 0.01, Δ700), followed by *Lindernia antipoda* (L.) Alston (1.66 ± 0.01, Δ700), *Euryale ferox* Salisb. (0.76 ± 0.12, Δ700), *Marsilea minuta* L. (0.69 ± 0.02, Δ700), *Cyperus iria* L. (0.58 ± 0.03, Δ700), and *Cyperus difformis* L. (0.51 ± 0.02, Δ700). The positive control BHT also had a quite high reducing capacity (0.27 ± 0.02, Δ700). The results showed that the reducing capacities for radical-scavenging of all the tested wetland medicinal plants were even higher than the positive controls.

Total polyphenol, flavonoid, and flavonol contents of the wetland medicinal plants

The total polyphenol, flavonoid, and flavonol contents of the water and methanol extracts of wetland medicinal plants are shown in Table 5 and 6, respectively. The total polyphenol content was expressed as μg of catechin equivalent per milligram of dry weight. For the water extracts, the total polyphenol content of the wetland medicinal plants ranged from 17.91 μg to 565.92 μg CE/mg; as for the methanol extract, the total polyphenol content ranged from 7.69 μg CE/mg to 551.50 μg CE/mg, and the difference of antioxidant capacities was also very large, up to 31 and 71 fold. It was found that *Rotala rotundifolia* (Wallich *ex* Roxb.) Koehne had a total

294 polyphenol content of 565.92 ± 4.45 μg CE/mg, followed by *Lindernia antipoda* (L.)
295 Alston (389.25 ± 19.12μg CE/mg), *Cyperus iria* L. (385.67 ± 5.62 μg CE/mg),
296 *Cyperus iria* L. (302.89 ± 21.19 μg CE/mg), *Typha orientalis* Presl (230.50 ± 1.41 μg
297 CE/mg), and *Cyperus difformis* L. (162.04 ± 10.16 μg CE/mg) in their water extracts
298 (Table 5). *Salix warburgii* O. Seem. had a total polyphenol content of 551.50 ± 17.57
299 μg CE/mg, followed by *Typha orientalis* Presl (494.17 ± 10.13 μg CE/mg), *Juncus*
300 *effusus* L. var. *decipiens* Buchen. (489.75 ± 53.28 μg CE/mg), *Lindernia antipoda* (L.)
301 Alston (356.70 ± 17.32 μg CE/mg), *Cyperus iria* L. (345.25 ± 9.81 μg CE/mg), and
302 *Kyllinga brevifolia* Rottb. (251.25 ± 1.90 μg CE/mg) in their methanol extracts (Table
303 6).

304 The total flavonoid content was expressed as μg of rutin equivalent per milligram
305 of dry weight. The total flavonoid contents in the water extracts of the wetland
306 medicinal plants ranged from 3.11 to 53.92 μg RE/mg, and the total flavonoid
307 contents in their methanol extracts ranged from 1.19 to 72.17 μg RE/mg, furthermore
308 the difference of antioxidant capacities was also very large, up to 17 and 60 fold
309 respectively. It was found that *Typha orientalis* Presl had the highest total flavonoid
310 content (53.92 ± 5.44 μg RE/mg), followed by *Rotala rotundifolia* (Wallich *ex* Roxb.)
311 Koehne (46.24 ± 0.39 μg RE/mg), and *Cyperus iria* L. (29.73 ± 0.51 μg RE/mg) in
312 their water extracts. *Eriocaulon sexangulare* L. had the highest total flavonoid content
313 (74.55 ± 1.50 μg RE/mg), followed by *Polygonum plebeium* R. Br. (72.17 ± 3.33 μg
314 CE/mg), *Typha orientalis* Presl (71.89 ± 0.42 μg RE/mg), and *Salix warburgii* O.
315 Seem. (70.34 ± 2.43 μg RE/mg) in their methanol extracts.

316 The total flavonol content was expressed as μg of catechin equivalent per
317 milligram of dry weight. The total flavonol content of the water extracts of the
318 wetland medicinal plants ranged from 0.05 to 14.05 μg CE/mg, and the flavonol

content of the methanol extracts ranged from 0.46 to 14.36 μg CE/mg and the difference of antioxidant capacities was also very large, up to 281 and 31 fold. It was found that *Cyperus iria* L. had the highest flavonol content (14.05 ± 0.88 μg CE/mg), followed by *Polygonum plebeium* R. Br. (13.47 ± 1.22 μg CE/mg), and *Salix warburgii* O. Seem. (5.54 ± 0.18 μg CE/mg) for the water extracts. *Cyperus imbricatus* Retz. had the highest flavonol content (14.36 ± 1.28 μg CE/mg), followed by *Cyperus iria* L. (13.41 ± 0.87 μg CE/mg), and *Typha orientalis* Presl (7.04 ± 0.10 μg CE/mg) for the methanol extracts.

Relationship between total antioxidant activity and total polyphenol content

The correlation coefficients (R^2) of total antioxidant activity (TEAC) and total polyphenol of the water and methanol extracts are shown in Fig. 1A and 1B. The R^2 values of TEAC and total polyphenol content of the water (Fig. 1A) and methanol (Fig. 1B) extracts were 0.14 and 0.25, respectively. By examining the above statistics, we could see that there was a low correlation between the TEAC and total polyphenol contents. The linear regression analysis indicated a low correlation between antioxidant activity and total polyphenol contents. Different species of wetland medicinal plants may influence the antioxidant activity as well. Therefore, high phenolic content was not an only important factor in determining the antioxidant capacities of these wetland medicinal plants.

DISCUSSION

From the antioxidant activities evaluated by TEAC assay, DPPH radical scavenging, reducing power, total polyphenol content, total flavonoid content and flavonol content, among the 31 wetland medicinal plants screened, *Rotala rotundifolia* (Wallich *ex* Roxb.) Koehne., *Juncus effusus* L. var. *decipiens* Buchen., *Cyperus iria* L., *Salix warburgii* O. Seem., *Lindernia antipoda* (L.) Alston, *Kyllinga brevifolia* Rottb., and *Typha orientalis* Presl exhibited best antioxidant activities.

Rotala rotundifolia (Wallich *ex* Roxb.) Koehne. has not been reported in any scientific papers before. This plant possesses antiradiation, anti-inflammatory, and antibacterial effects. The present study provided valuable preliminary data through demonstration of its efficient antioxidant capacity. Isolation and characterization of its individual active components and *in vivo* relevance await further comprehensive studies.

Juncus effusus L. var. *decipiens* Buchen. possesses anti-depressant, anti-inflammatory, and antibacterial effects. To our knowledge, there was no prior report as to the antioxidant activity of this plant. This study rendered valuable preliminary data through demonstration of its high antioxidant capacity. To study the phenolic constituents from the dry stem of *Juncus effusus* L., six phenolic constituents were purified and identified as 7-carboxy-2-hydroxy-1-methyl-5-vinyl-9, 10-dihydrophenanthrene, 2,3-isopylidene-1-O-ferulic acid glyceride, (2S)-2, 3-isopylidene-1-0-p-coumaroyl glyceride, dehydroeffusal, p-hydroxybenzaldehyde and luteolin-5,3'-dimethyl ether (Li et al., 2007). Some of them might be antioxidant components.

Cyperus iria L. has not been reported in any scientific papers before. This plant possesses rheumatic, antidiuretic, and anti-inflammatory effects. The present study showed first hand data on the antixodiant capacity of *Cyperus iria*. Isolation and

366 characterization of its individual active components and *in vivo* relevance of such
367 activity awaits further comprehensive studies.

368 *Salix warburgii* O. Seem. possesses anticoagulant, anti-inflammatory, and
369 antibacterial effects. To our knowledge, there was no prior report on the antioxidant
370 activity of this plant. This paper studied the antioxidant effects of *Salix warburgii* for
371 the first time; a bioassay-guided *in vitro* screen has revealed that a 70% methanol
372 extract of the leaves of *Salix matsudana* showed considerable inhibitory activity
373 against cyclooxygenases (COX-1 and COX-2) (Li et al., 2008). A subsequent
374 phytochemical study led to the isolation of some compounds: matsudone A, luteolin,
375 isoquercitrin, 7-methoxyflavone, luteolin 7-O-glucoside, and 4',7-dihydroxyflavone.
376 These isolated compounds were found to possess activities in inhibiting against
377 COX-1 or COX-2.

378 *Lindernia antipoda* (L.) Alston possesses analgesic and anti-inflammatory effects.
379 There has been no prior report regarding the antioxidant activity of this plant. This
380 study provided valuable data by demonstrating the high antioxidant capacity of
381 *Lindernia antipoda* for the first time. However, isolation and characterization of its
382 active components and their *in vivo* relevance await further comprehensive studies.

383 *Kyllinga brevifolia* Rottb. possesses analgesic and anti-inflammatory effects.
384 Oral administration of doses up to 3.0 g/kg did not provoke any toxic symptoms. The
385 toxicity of this plant was observed to be dose dependent and its intraperitoneal LD_{50}
386 was found to be 575 mg/kg. It is used in traditional medicine to alleviate stress or as a
387 sedative agent (Helliön-Ibarrola et al., 1999).

388 *Typha orientalis* Presl is a commonly used Chinese herbal drug which has been
389 shown to possess blood circulation stimulating, hypertension relieving and nerve
390 soothing effects. There was no prior report regarding the antioxidant activity of this

plant.

Phenolic compounds such as flavonoids, phenolic acid and tannins possess diverse biological activities such as anti-inflammatory, anti-carcinogenic and anti-atherosclerotic activities. These activities might be related to their antioxidant activities (Chung et al., 1998; Wong et al., 2006). Both flavonoids and flavonols belong to polyphenolic compounds. Polyphenolic compounds have an important role in stabilizing lipid oxidation and are associated with antioxidant activity (Yen et al., 1993). Phenolic compounds may contribute directly to antioxidative action (Duh et al., 1999). It is suggested that polyphenolic compounds have inhibitory effects on mutagenesis and carcinogenesis in humans when as much as 1.0 g is ingested from a diet rich in fruits and vegetables daily (Tanaka et al., 1998). The antioxidative activities observed could be ascribed both to the different mechanisms exerted by different phenolic compounds and to the synergistic effects of different compounds. The antioxidant assays used in this study measured the oxidative products at the early and final stages of oxidation. Antioxidants have different functional properties, for example quercetin, rutin, and catechin can scavenge reactive oxygen species (Liu et al., 2008); *p*-coumaric acids, on the other hand, inhibits the generation of free radicals and chain-breaking activity (Laranjinha et al., 1995) and metal chelation (Van-Acker et al., 1998). These compounds, as well as flavonoids and other organic acids, are highly effective electron donors. However, the components which were responsible for the antioxidative activities of the wetland medicinal plants are still currently unclear. Therefore, further work must be performed to isolate and identify these components.

In conclusion, the results from these *in vitro* experiments, including ABTS radical monocation scavenging (Table 2), DPPH radical scavenging (Table 3),

reducing power method (Table 4), total polyphenol content, total flavonoid content and total flavonol content (Table 5 and 6), demonstrated that phytochemicals in the wetland medicinal plants might have significant effects on antioxidant activities. However, the quantity of polyphenols and flavonoids found in the wetland medicinal plant extracts were not directly related to their antioxidant activities. The additive roles of phytochemicals might contribute significantly to the potent antioxidant activity. Hence, some wetland medicinal plants could be used as an easy accessible source of natural antioxidants in pharmaceutical and medical industries. For this reason, further work should be performed to isolate and identify the antioxidative components of wetland medicinal plants.

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531 to their antimutagenicity. J. Agric. Food Chem. **46:** 849-854.

532 Table 1. The yield of water and methanol extracts of the wetland medicinal plants

Scientific name	Yield (%, w/w) [a]	
	Water extract	Ethanol extract
Acorus gramineus Soland.	12.96	8.37
Avicennia marina (Forsk.) Vierh. -leaf	5.47	5.83
Avicennia marina (Forsk.) Vierh. -root	17.84	24.37
Alisma orientalis (Sam.) Juzep.	43.33	14.84
Alternanthera sessilis (L.) R. Br.	15.91	12.14
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	11.24	26.76
Commelina communis L.	11.76	14.21
Cyperus difformis L.	23.22	17.84
Cyperus imbricatus Retz.	36.33	9.79
Cyperus iria L.	11.07	7.62
Eichhornia crassipes (Mart.) Solms	14.35	13.05
Echinochloa crus-galli (L.) Beauv.	6.77	6.39
Egeria densa Planch.	20.77	3.42
Euryale ferox Salisb.	14.44	1.43
Eriocaulon sexangulare L.	12.45	2.53
Fimbristylis littoralis Gaud	10.52	3.92
Hedyotis corymbosa (L.) Lam.	21.19	10.66
Hygrophila pogonocalyx Hayata	12.84	6.41
Juncus effusus L. var. *decipiens* Buchen.	13.04	11.34
Kyllinga brevifolia Rottb.	12.18	4.45
Lindernia antipoda (L.) Alston	63.33	34.03
Marsilea minuta L.	37.03	11.27
Pilea microphylla (L.) Liebm.	4.96	10.76
Phyla nodiflora (L.) Greene	7.86	9.18
Polygonum plebeium R. Br.	45.99	17.31
Pistia stratiotes L.	70.18	21.58
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	4.24	12.31
Spirodela punctata G. F. W. Meyer	13.96	11.42
Salix warburgii O. Seem.	14.63	15.44
Typha orientalis Presl	19.7	0.89
Torulinium odoratum (L.) S. Hooper	39.83	12.76

533 [a] On dried weight basis.

534

535 Table 2. The TEAC of the water and methanol extracts of the wetland medicinal
536 plants.

Scientific name and positive controls	TEAC[a] (μM Trolox/mg ± SD)	
	Water extracted	Methanol extracted
GSH	1827.68 ± 76.84	Not detected
BHT	Not detected	11869.41 ± 34.63
Acorus gramineus Soland.	159.52 ± 2.57	225.65 ± 9.45
Avicennia marina (Forsk.) Vierh. -leaf	376.17 ± 10.42	54.15 ± 2.11
Avicennia marina (Forsk.) Vierh. -root	381.85 ± 13.07	177.00 ± 2.13
Alisma orientalis (Sam.) Juzep.	12.33 ± 3.44	19.08 ± 7.96
Alternanthera sessilis (L.) R. Br.	156.38 ± 9.48	148.46 ± 6.64
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	47.23 ± 3.66	81.77 ± 4.10
Commelina communis L.	113.02 ± 1.96	96.13 ± 7.69
Cyperus difformis L.	132.00 ± 4.83	15.33 ± 16.20
Cyperus imbricatus Retz.	112.35 ± 4.74	27.35 ± 4.81
Cyperus iria L.	762.04 ± 33.80	769.41 ± 53.57
Eichhornia crassipes (Mart.) Solms	102.13 ± 2.66	143.33 ± 6.39
Echinochloa crus-galli (L.) Beauv.	448.98 ± 6.41	39.56 ± 20.28
Egeria densa Planch.	37.10 ± 2.17	5.69 ± 7.58
Euryale ferox Salisb.	14.58 ± 1.11	350.73 ± 4.13
Eriocaulon sexangulare L.	77.58 ± 3.57	222.65 ± 0.86
Fimbristylis littoralis Gaud	311.73 ± 3.71	87.17 ± 5.02
Hedyotis corymbosa (L.) Lam.	283.58 ± 4.45	56.73 ± 7.18
Hygrophila pogonocalyx Hayata	69.40 ± 0.94	43.38 ± 5.03
Juncus effusus L. var. *decipiens* Buchen.	971.14 ± 49.68	2074.35 ± 116.19
Kyllinga brevifolia Rottb.	462.67 ± 9.49	342.52 ± 10.91
Lindernia antipoda (L.) Alston	320.35 ± 2.80	311.23 ± 16.05
Marsilea minuta L.	94.27 ± 4.82	196.25 ± 13.50
Pilea microphylla (L.) Liebm.	165.44 ± 0.38	248.17 ± 34.50
Phyla nodiflora (L.) Greene	97.04 ± 1.53	86.21 ± 12.58
Polygonum plebeium R. Br.	364.04 ± 1.07	175.44 ± 9.47
Pistia stratiotes L.	7.52 ± 3.64	34.79 ± 2.63
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	1753.41 ± 76.99	159.90 ± 15.52
Spirodela punctata G. F. W. Meyer	360.25 ± 7.70	104.17 ± 5.36
Salix warburgii O. Seem.	657.57 ± 18.37	931.45 ± 84.14
Typha orientalis Presl	344.13 ± 5.48	651.22 ± 14.95
Torulinium odoratum (L.) S. Hooper	32.71 ± 0.71	203.67 ± 52.57

537 [a]Values represented mean ± S.D. of three parallel measurements (P<0.05).

538

539 Table 3. The DPPH radical scavenging activity of the water and methanol extracts of
540 the wetland medicinal plants.

Scientific name and positive controls	DPPH radical scavenging activity[a] (IC_{50}, μg/mL)	
	Water extract	Methanol extract
GSH	71.77 ± 2.09	Not detected
BHT	Not detected	139.56 ± 2.96
Acorus gramineus Soland.	896.90 ± 7.60	1045.51 ± 0.69
Avicennia marina (Forsk.) Vierh. -leaf	271.71 ± 1.28	>2,000
Avicennia marina (Forsk.) Vierh. -root	404.19 ± 1.18	713.99 ± 0.24
Alisma orientalis (Sam.) Juzep.	>2,000	>2,000
Alternanthera sessilis (L.) R. Br.	844.69 ± 6.42	946.79 ± 8.39
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	>2,000	>2,000
Commelina communis L.	>2,000	>2,000
Cyperus difformis L.	1125.67 ± 1.22	489.04 ± 3.82
Cyperus imbricatus Retz.	1882.64 ± 3.92	242.55 ± 3.11
Cyperus iria L.	194.45 ± 0.32	167.18 ± 0.64
Eichhornia crassipes (Mart.) Solms	>2,000	>2,000
Echinochloa crus-galli (L.) Beauv.	548.23 ± 4.62	>2,000
Egeria densa Planch.	>2,000	>2,000
Euryale ferox Salisb.	>2,000	307.35 ± 1.61
Eriocaulon sexangulare L.	>2,000	>2,000
Fimbristylis littoralis Gaud	810.61 ± 6.58	>2,000
Hedyotis corymbosa (L.) Lam.	668.89 ± 8.62	>2,000
Hygrophila pogonocalyx Hayata	1520.06 ± 5.25	>2,000
Juncus effusus L. var. *decipiens* Buchen.	456.88 ± 3.88	108.95 ± 4.47
Kyllinga brevifolia Rottb.	379.52 ± 2.52	523.55 ± 0.091
Lindernia antipoda (L.) Alston	189.14 ± 4.55	144.61 ± 2.53
Marsilea minuta L.	1400.48 ± 3.2	613.76 ± 1.67
Pilea microphylla (L.) Liebm.	>2,000	423.14 ± 5.61
Phyla nodiflora (L.) Greene	>2,000	789.26 ± 5.84
Polygonum plebeium R. Br.	301.52 ± 4.62	>2,000
Pistia stratiotes L.	>2,000	>2,000
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	94.89 ± 0.31	721.89 ± 3.91
Spirodela punctata G. F. W. Meyer	432.20 ± 4.63	1094.73 ± 12.61
Salix warburgii O. Seem.	112.69 ± 0.28	59.58 ± 0.33
Typha orientalis Presl	533.59 ± 4.92	208.01 ± 1.46
Torulinium odoratum (L.) S. Hooper	>2,000	>2,000

541 [a] Values represented mean ± S.D. of three parallel measurements (P<0.05).
542

543

544 Table 4. The reducing power of the water and methanol extracts of the wetland
545 medicinal plants

546

Scientific name and positive controls	Reducing power Δ700[a] (Mean ± SD)	
	Water extract	methanol extract
GSH	1.80 ± 0.01	Not detected
BHT	Not detested	0.27 ± 0.02
Acorus gramineus Soland.	0.36 ± 0.01	0.04 ± 0.01
Avicennia marina (Forsk.) Vierh. -leaf	1.11 ± 0.01	0.06 ± 0.01
Avicennia marina (Forsk.) Vierh. -root	1.010 ± 0.02	0.36 ± 0.02
Alisma orientalis (Sam.) Juzep.	0.05 ± 0.01	0.15 ± 0.02
Alternanthera sessilis (L.) R. Br.	0.46 ± 0.01	0.19 ± 0.02
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	0.13 ± 0.01	0.17 ± 0.01
Commelina communis L.	0.23 ± 0.01	0.40 ± 0.01
Cyperus difformis L.	0.39 ± 0.01	0.51 ± 0.02
Cyperus imbricatus Retz.	0.27 ± 0.02	0.41 ± 0.03
Cyperus iria L.	1.56 ± 0.01	0.58 ± 0.03
Eichhornia crassipes (Mart.) Solms	0.17 ± 0.01	0.26 ± 0.01
Echinochloa crus-galli (L.) Beauv.	0.63 ± 0.02	0.03 ± 0.01
Egeria densa Planch.	0.02 ± 0.01	0.04 ± 0.01
Euryale ferox Salisb.	0.07 ± 0.01	0.76 ± 0.12
Eriocaulon sexangulare L.	0.09 ± 0.01	0.32 ± 0.01
Fimbristylis littoralis Gaud	0.40 ± 0.01	0.01 ± 0.01
Hedyotis corymbosa (L.) Lam.	0.552 ± 0.02	0.06 ± 0.00
Hygrophila pogonocalyx Hayata	0.310 ± 0.01	0.09 ± 0.02
Juncus effusus L. var. *decipiens* Buchen.	0.56 ± 0.01	0.26 ± 0.05
Kyllinga brevifolia Rottb.	0.74 ± 0.01	0.29 ± 0.08
Lindernia antipoda (L.) Alston	1.60 ± 0.07	1.66 ± 0.01
Marsilea minuta L.	0.27 ± 0.01	0.69 ± 0.02
Pilea microphylla (L.) Liebm.	0.08 ± 0.03	0.29 ± 0.02
Phyla nodiflora (L.) Greene	0.33 ± 0.02	0.36 ± 0.03
Polygonum plebeium R. Br.	1.17 ± 0.03	0.36 ± 0.02
Pistia stratiotes L.	0.02 ± 0.01	0.04 ± 0.01
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	1.61 ± 0.05	0.25 ± 0.01
Spirodela punctata G. F. W. Meyer	0.71 ± 0.05	0.10 ± 0.04
Salix warburgii O. Seem.	1.64 ± 0.01	1.68 ± 0.01
Typha orientalis Presl	0.58 ± 0.01	0.46 ± 0.02
Torulinium odoratum (L.) S. Hooper	0.09 ± 0.01	0.27 ± 0.05

547 [a] Values represented mean ± S.D. of three parallel measurements (P<0.05).

548

549

550 Table 5. Total polyphenol, flavonoid, and flavonol content of the water extracts of the

551 wetland medicinal plants [a].

552

Scientific name	Water extracted		
	Polyphenol [a, b] (μg CE/mg)	Flavonoid [a, c] (μg RE/mg)	Flavonol [a, b] (μg CE/mg)
Acorus gramineus Soland.	91.50 ± 1.25	13.81 ± 4.93	2.06 ± 0.14
Avicennia marina (Forsk.) Vierh. -leaf	109.25 ± 1.67	27.55 ± 0.24	0.34 ± 0.02
Avicennia marina (Forsk.) Vierh. -root	102.1 ± 7.55	7.78 ± 0.07	0.42 ± 0.01
Alisma orientalis (Sam.) Juzep.	37.04 ± 1.81	3.71 ± 0.05	1.06 ± 0.01
Alternanthera sessilis (L.) R. Br.	137.67 ± 3.81	26.44 ± 0.53	1.56 ± 9.11
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	78.45 ± 0.93	4.63 ± 0.05	1.23 ± 0.02
Commelina communis L.	113.79 ± 5.76	15.72 ± 0.20	1.04 ± 0.01
Cyperus difformis L.	162.04 ± 10.16	18.96 ± 0.53	1.15 ± 0.01
Cyperus imbricatus Retz.	140.87 ± 7.01	13.70 ± 0.37	1.31 ± 0.01
Cyperus iria L.	385.67 ± 5.62	29.73 ± 0.51	14.05 ± 0.88
Eichhornia crassipes (Mart.) Solms	90.12 ± 7.26	9.97 ± 0.23	1.14 ± 0.01
Echinochloa crus-galli (L.) Beauv.	108.33 ± 9.26	14.88 ± 1.33	2.93 ± 1.98
Egeria densa Planch.	24.66 ± 0.10	5.85 ± 0.09	1.05 ± 0.01
Euryale ferox Salisb.	28.16 ± 0.49	3.28 ± 0.21	1.93 ± 0.02
Eriocaulon sexangulare L.	88.62 ± 0.91	9.57 ± 0.25	1.25 ± 0.02
Fimbristylis littoralis Gaud	87.50 ± 20.02	14.16 ± 0.36	3.13 ± 0.08
Hedyotis corymbosa (L.) Lam.	157.50 ± 7.53	17.04 ± 0.67	0.71 ± 0.01
Hygrophila pogonocalyx Hayata	81.25 ± 9.11	7.86 ± 0.08	1.22 ± 0.01
Juncus effusus L. var. *decipiens* Buchen.	37.33 ± 10.37	8.79 ± 2.88	0.38 ± 0.01
Kyllinga brevifolia Rottb.	215.92 ± 1.23	9.54 ± 0.44	1.69 ± 0.01
Lindernia antipoda (L.) Alston	389.25 ± 19.12	22.68 ± 0.57	2.23 ± 0.02
Marsilea minuta L.	102.41 ± 6.93	12.42 ± 0.61	3.97 ± 0.15
Pilea microphylla (L.) Liebm.	81.67 ± 3.59	10.00 ± 0.40	0.05 ± 0.01
Phyla nodiflora (L.) Greene	137.04 ± 4.13	16.76 ± 0.10	1.61 ± 0.01
Polygonum plebeium R. Br.	64.10 ± 10.48	17.22 ± 0.25	13.47 ± 1.22
Pistia stratiotes L.	17.91 ± 0.10	3.33 ± 0.04	0.85 ± 0.01
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	565.92 ± 4.45	46.24 ± 0.39	4.50 ± 0.27
Spirodela punctata G. F. W. Meyer	67.67 ± 11.58	21.37 ± 1.27	0.81 ± 0.02
Salix warburgii O. Seem.	302.89 ± 21.19	34.20 ± 1.36	5.54 ± 0.18
Typha orientalis Presl	230.50 ± 1.41	53.92 ± 5.44	2.89 ± 0.01
Torulinium odoratum (L.) S. Hooper	43.91 ± 0.55	3.11 ± 0.04	2.39 ± 0.04

553 [a] Values represented mean ± S.D. of three parallel measurements.

554 [b] Data expressed in μg catechin equivalent / mg dry weight (μg CE/mg).

555 [c] Data expressed in μg rutin equivalent / mg dry weight (μg RE/mg).

556

557 Table 6. Total polyphenol, flavonoid, and flavonol content of the methanol extracts of
558 the wetland medicinal plants [a].
559

Scientific name	Methanol extracted		
	Polyphenol [a, b] (μg CE/mg)	Flavonoid [a, c] (μg RE/mg)	Flavonol [a, b] (μg CE/mg)
Acorus gramineus Soland.	160.58 ± 61.15	19.98 ± 31.55	1.38 ± 0.01
Avicennia marina (Forsk.) Vierh. -leaf	7.69 ± 24.50	18.34 ± 24.74	1.49 ± 0.16
Avicennia marina (Forsk.) Vierh. -root	59.76 ± 3.27	42.08 ± 1.22	0.46 ± 0.01
Alisma orientalis (Sam.) Juzep.	37.45 ± 0.28	6.25 ± 1.93	0.94 ± 0.01
Alternanthera sessilis (L.) R. Br.	152.83 ± 11.30	24.07 ± 18.78	3.79 ± 0.38
Cyperus alternifolius L. subsp. *flabelliformis* (Rottb.) Kukenthal	105.58 ± 13.19	20.51 ± 3.02	3.84 ± 0.05
Commelina communis L.	129.16 ± 4.99	21.21 ± 0.24	1.36 ± 0.01
Cyperus difformis L.	39.01 ± 6.05	15.31 ± 0.68	2.29 ± 0.02
Cyperus imbricatus Retz.	112.07 ± 10.79	26.11 ± 9.91	14.36 ± 1.28
Cyperus iria L.	345.25 ± 9.81	46.88 ± 0.47	13.41 ± 0.87
Eichhornia crassipes (Mart.) Solms	184 ± 19.12	25.60 ± 6.30	3.08 ± 0.06
Echinochloa crus-galli (L.) Beauv.	80.08 ± 8.80	24.21 ± 10.61	2.00 ± 0.38
Egeria densa Planch.	81.79 ± 18.52	12.5.11 ± 5.41	2.95 ± 0.01
Euryale ferox Salisb.	213.58 ± 7.29	16.70 ± 2.31	3.43 ± 0.01
Eriocaulon sexangulare L.	133.02 ± 5.12	74.55 ± 1.50	6.15 ± 0.86
Fimbristylis littoralis Gaud	107.08 ± 4.12	19.16 ± 5.42	2.00 ± 0.37
Hedyotis corymbosa (L.) Lam.	103.67 ± 1.46	26.02 ± 6.49	2.57 ± 0.16
Hygrophila pogonocalyx Hayata	18.05 ± 8.56	1.19 ± 0.53	2.54 ± 1.34
Juncus effusus L. var. *decipiens* Buchen.	489.75 ± 53.28	30.16 ± 5.07	1.60 ± 0.05
Kyllinga brevifolia Rottb.	251.25 ± 1.90	41.86 ± 2.19	3.85 ± 0.26
Lindernia antipoda (L.) Alston	356.70 ± 17.32	35.21 ± 2.42	2.12 ± 0.01
Marsilea minuta L.	47.81 ± 9.58	12.05 ± 3.84	1.45 ± 0.08
Pilea microphylla (L.) Liebm.	244.08 ± 14.43	14.78 ± 3.38	5.98 ± 0.78
Phyla nodiflora (L.) Greene	29.53 ± 4.71	11.10 ± 1.86	2.68 ± 0.10
Polygonum plebeium R. Br.	44.32 ± 11.38	72.17 ± 3.33	2.82 ± 0.39
Pistia stratiotes L.	51.79 ± 1.12	20.22 ± 2.58	4.97 ± 0.12
Rotala rotundifolia (Wallich *ex* Roxb.) Koehne	122.92 ± 3.67	28.14 ± 5.48	2.43 ± 0.33
Spirodela punctata G. F. W. Meyer	204.00 ± 4.39	20.84 ± 1.53	3.77 ± 0.29
Salix warburgii O. Seem.	551.50 ± 17.57	70.34 ± 2.43	6.62 ± 0.31
Typha orientalis Presl	494.17 ± 10.13	71.89 ± 0.42	7.04 ± 0.10
Torulinium odoratum (L.) S. Hooper	54.06 ± 11.80	12.27 ± 2.27	3.33 ± 1.56

560 [a] Values represented mean ± S.D. of three parallel measurements.

561 [b] Data expressed in μg catechin equivalent / mg dry weight (μg CE/mg).

562 [c] Data expressed in μg rutin equivalent / mg dry weight (μg RE/mg).

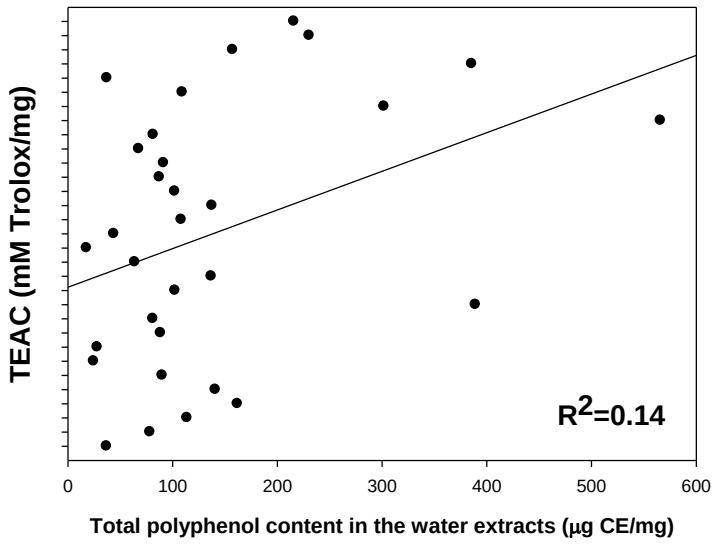
563

Figure legend

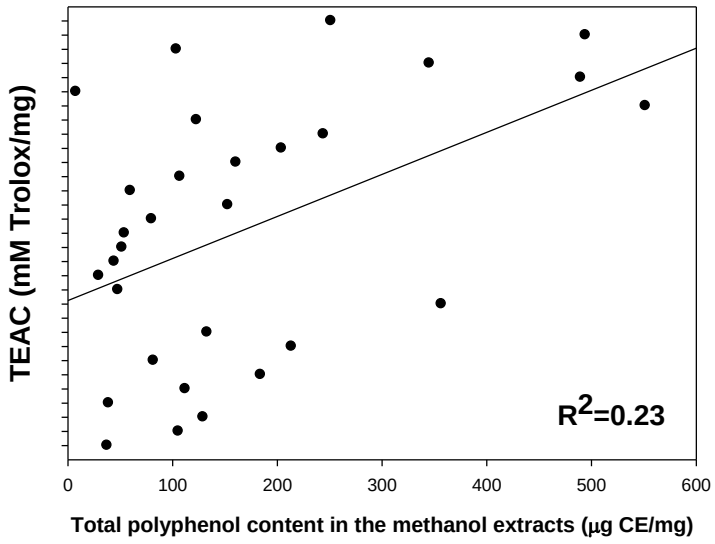
Figure 1. Correlation coefficients (R^2) of TEAC and total polyphenol contents in the water (A) and methanol (B) extracts of the wetland medicinal plants.

Figure 1.

A.


TEAC (mM Trolox/mg)
0
100
200
300
400
500
600
R2=0.14
Total polyphenol content in the water extracts (μg CE/mg)

B.


TEAC (mM Trolox/mg)
0
100
200
300
400
500
600
R2=0.23
Total polyphenol content in the methanol extracts (μg CE/mg)

臺灣濕地藥用植物之抗氧化活性和總多酚含量

何玉鈴[1] 黃世勳[1] 鄧正賢[2] 林耀輝[3] 張永勳[4] 黃冠中[4*]

[1] 弘光科技大學護理系

2 亞洲大學保健營養生技學系

[3] 中央研究院植物暨微生物學研究所

[4] 中國醫藥大學中國藥學暨中藥資源系

本文章研究目的是評估台灣濕地藥用植物之甲醇和水萃取物之抗氧化活性。評估的項目，包括 ABTS 清除，清除 DPPH 自由基，還原力，總多酚含量，總類黃酮類含量、總黃酮醇類含量。結果顯示，31 種濕地藥用植物中以水豬母乳、燈心草、碎米莎草、水柳、泥花草、短葉水蜈蚣和香蒲共七種，其抗氧化物和多酚類均具不錯之效果和含量。且由抗氧化活性和總多酚含量之線性相關係數結果得知，水萃取物相關係數為 0.14 和甲醇萃取物相關係數為 0.23。結果顯示，植物中化學物質含量可能有助於顯著的抗氧化活性，但這種關係並不一定成正比。濕地藥用植物未來在醫藥和保健食品行業中將可作為一個容易取得的天然抗氧化劑的來源。

關鍵詞：濕地藥用植物; 抗氧化劑; 多酚類; 黃酮類；黃酮醇類