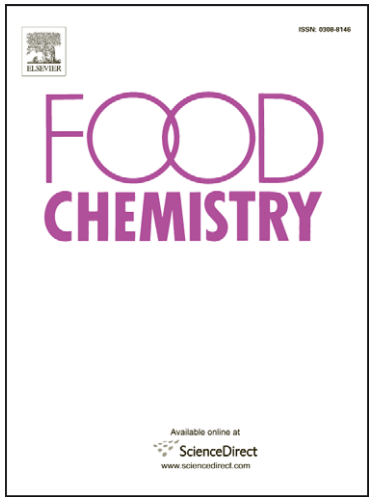

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PII: S0308-8146(11)00514-0
DOI: 10.1016/j.foodchem.2011.03.113
Reference: FOCH 10912

To appear in: *Food Chemistry*

Received Date: 24 October 2010
Revised Date: 21 February 2011
Accepted Date: 30 March 2011

Please cite this article as: Shi, Y-X., Xu, Y-K., Hu, H-B., Na, Z., Wang, W-H., Preliminary assessment of antioxidant activity of young edible leaves of seven *Ficus* species in the ethnic diet in Xishuangbanna, Southwest China, *Food Chemistry* (2011), doi: 10.1016/j.foodchem.2011.03.113

Preliminary assessment of antioxidant activity of young edible leaves of seven *Ficus* species in the ethnic diet in Xishuangbanna, Southwest China

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ABSTRACT

The young leaves of seven *Ficus* species including *F. virens* var. *sublanceolata*, *F. auriculata, F. vasculosa, F. callosa, F. virens* var. *verins, F. racemosa* and *F. oligodon* are traditionally consumed by local people in Xishuangbanna. The dry young leaves were studied for their total phenolic and flavonoid contents. The 90% ethanolic extracts of the young leaves were screened for potential antioxidant capacity by employing different *in vitro* assays including $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radical scavenging capacities, ferric reducing power and lipid peroxidation inhibition properties. Extracts from *F. virens* var. *sublanceolata* and *F. auriculata* showed higher antioxidant activity in all the systems than other species. We concluded that these two species are promising sources of natural dietary antioxidants. According to our statistical analysis, the total phenolic and flavonoid contents appear to be responsible, at least in part, for the extracts' excellent antioxidant capacity and all the extracts exhibited dose-dependent antioxidant activity.

Keywords: Ficus species; Phenolics; Flavonoids; Free radicals; Antioxidant activity; Reducing power; Lipid peroxidation

1. Introduction

The use of *Ficus* species as food or pharmacological agents to improve human health has a history of about ten thousand years. Some of the species are used in Ayurvedic and Traditional Chinese Medicine acording to Lansky, Paavilainen, Pawlus and Newman (2008). These researchers have reported the antioxidant actions of *Ficus* components and the contemporary ethnopharmacological uses of *Ficus* species against cancer and inflammation. Species including *F. benghalensis*, *F. carica*, *F. microcarpa* and *F. racemosa* have been reported. However, the antioxidant profile of most species belonging to *Ficus* have remained unexamined and lack extensive documentation.

Xishuangbanna in southwest China, bordered with Laos and Myanmar, is one of the biodiversity hotspots for conservation priorities (Myers, Mittermeier, Mittermeier, Da Fonceca, & Kent, 2000). It is inhabited by 13 ethnic groups with a total population of about 1 million in 2010. These ethnic groups traditionally lived on gathering and hunting in the tropical forest for their subsistence, and accumulated rich knowledge about uses of wild plants as vegetables. In recent decades, wild vegetables have become an important source of cash income for local communities, due to their high nutritional value, special local flavour and free from chemical residues. According to Xu, Tao, Liu, Yan, and Dao (2004), the income generated from wild vegetable market accounted for 30.9% of the total income from vegetable sales. They also reported that over 300 vascular plant species and varieties in Xishuangbanna are consumed as wild vegetables by the ethnic groups. Statistical analysis showed, at genus level, *Ficus* contains the most abundant edible species, including the seven species we intend to study, namely *F. virens* Ait var. *sublanceolata* (Miq.) Corner, *F. auriculata* Lour., *F. vasculosa* Wall ex Miq., *F. callosa* Willd, *F. virens* Ait var. *verins*, *F. racemosa* L. and *F. oligodon* Miq.. The young leaves' nutrient contents have already been reported (Xu, Liu, Xiao, Wu, Dao, & Cai, 2005). However, apart from *F.*

racemosa no scientific literature exists on the antioxidant capacity of these plants. It is known that a dietary or pharmaceutical supplement of extrinsic antioxidant compounds to neutralize excessive harmful free radicals is important for maintaining human health. For example, fruits of *Ficus carica* (figs) have high phenolic antioxidant concentrations, and antioxidants from figs can protect lipoproteins in human plasma from oxidation and produce a significant increase in plasma antioxidant capacity after consumption (Vinson, Zubik, Bose, Samman, & Proch, 2005). In this research, we measured the total phenolic and flavonoid contents as well as total antioxidant activity of the seven *Ficus* species mentioned above. Due to the complex nature of phytochemicals, the antioxidant activity of plant extracts cannot be evaluated by only a single method. Therefore, commonly accepted assays, including methods on $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radical scavenging capacities, ferric reducing power and linoleic acid peroxidation inhibition properties, were employed to evaluate the total antioxidant effects. The study may give rise to further research on the application of these edible plants in pharmaceuticals and functional foods.

2. Materials and methods

2.1. Chemicals

2,2-azobis-3-ethylbenzthiazoline-6-sulphonic acid (ABTS) was purchased from Bio Basic inc. (Markham, Ontario, Canada). Folin-Ciocalteu phenol reagent, α,α-diphenyl-β-picrylhydrazyl ($DPPH^{\bullet}$) and linoleic acid were purchased from Sigma Chemical Co. (St. Louis, MO, USA). Rutin, trichloroacetic acid (TCA), ferric chloride, ferrous chloride, aluminium chloride, ammonium thiocyanate, ethylenediamine tetracetic acid (EDTA), sodium nitrite, potassium ferricyanide, gallic acid and other chemicals used were purchased from Sinopharm Chemical Reagent Co. Ltd. (Shanghai, China). All reagents were of analytical grade.

68 *2.2. Plant material and extraction*

69 All of the seven young leaf samples were collected from three separate locations in Xishuangbanna
70 Tropical Botanical Garden, Chinese Academy of Science (Yunnan, China). The leaves were air-dried in
71 shade and pulverized with a household food processor. After that, the dried powder was weighed and
72 extracted with 90% aqueous ethanol for about 36 hrs in a shaker (120 rpm) at 45^{o}C. The residues were
73 re-extracted twice under the same conditions to obtain ethanol extracts. The resulting extracts were
74 pooled and centrifuged at 4000 g for 15 min. The collected supernatants were evaporated *in vacuo* at
75 45^{o}C to dryness, weighed and stored in a desiccator in the dark for further use.

76 *2.3. Determination of ethanol extractable total phenolics and flavonoids*

77 *2.3.1. Contents of ethanol extractable total phenolics*

78 Total phenolic contents (TPC) were determined with Folin-Ciocalteau reagent (Karadeniz, Burdurlu,
79 Koca, & Soyer, 2005; Kaur & Kapoor, 2002). A 0.5 ml aliquot of a methanolic solution of each extracts
80 (10 mg/ml) was taken in a 10 ml colorimeter tube and 7 ml of distilled water and 0.5 ml of
81 Folin–Ciocalteau reagent were added. The solution was well mixed and allowed to stand at room
82 temperature for 3 min. Two ml of 20% aqueous sodium carbonate was added and the contents were
83 mixed thoroughly. Absorbance of the resultant solution was measured at 738 nm after 1 h. The TPC
84 was calculated from a standard calibration curve based on gallic acid.

85 *2.3.2. Contents of ethanol extractable flavonoids*

86 Flavonoid contents of the samples were determined according to Karadeniz et al. (2005). One ml of
87 methanolic solution of each extract (10 mg/ml) was placed in a 10 ml colorimeter tube, then 5 ml of
88 distilled water and 0.3 ml of 5% aqueous $NaNO_2$ were added. The solution was mixed well and allowed
89 to stand at room temperature for 5 min. Then 0.6 ml of 10% aqueous $AlCl_3{\cdot}6H_2O$ was added. After 6

min, 2 ml of 1 M NaOH was added and the final volume was made up to 10 ml with distilled water. The solution was mixed thoroughly and the absorbance was read at 510 nm. Flavonoid content was calculated from the standard calibration curve based on rutin.

2.4. Radical scavenging assays

2.4.1 Scavenging effect on ABTS$^{\bullet+}$ radicals

The assay was a slightly modified version of Subhasree, Baskar, Keerthana, Susan and Rajasekaran (2009). Seven mM ABTS solutions were prepared and reacted with 2.45 mM aqueous ammonium persulfate solution. The mixture was then kept for 12-16 hrs in the dark at room temperature, to produce a dark green solution containing ABTS$^{\bullet+}$ radical cations. The initial absorbance at 745 nm was read. The ABTS$^{\bullet+}$ solution was diluted with ethanol to an absorbance of about 0.7 (± 0.02) at 745 nm and equilibrated at 30 ^{o}C. Different concentrations of the methanolic solution of each extract (0.1 – 0.5 mg/ml) were prepared and 0.5 ml of the extract was mixed with 4.5 ml of ABTS$^{\bullet+}$ working standard in a 5 ml colorimeter tube. The absorbance was measured exactly 1 min after initial mixing and then for 6 additional min. The final absorbance was noted. Gallic acid was employed as a reference and the percentage inhibition was calculated according to the formula:

$$\text{ABTS}^{\bullet+}\text{ radical scavenging (\%)} = [(A_{control} - A_{sample})/A_{control}] \times 100$$

Where A_{sample} is the absorbance of the solution when the extract/reference has been added at a particular level, and $A_{control}$ is the absorbance of the ABTS$^{\bullet+}$ working standard without extract added. All analyses were run in triplicates and mean values were calculated.

2.4.2. Scavenging effects on DPPH$^{\bullet}$ radicals

The ability of prepared extracts to scavenge DPPH$^{\bullet}$ radicals was determined by the method described by Brandwilliams, Cuvelier and Berset (1995) with slight modifications. One ml methanol solution of

each extract in different concentrations (0.1 – 0.5 mg/ml) was added to 9 ml methanolic solution of $DPPH^{\bullet}$ (6×10^{-5} M). The solution was well mixed and then left at room temperature for 15 min in the dark. The absorbance of the resulting solution was read at 517 nm. Gallic acid was employed as a reference and the radical scavenging activity was calculated as a percentage of $DPPH^{\bullet}$ discolouration using the equation:

$$DPPH^{\bullet} \text{ radical scavenging } (\%) = [(A_{control} - A_{sample})/A_{control}] \times 100$$

Where A_{sample} is the absorbance of the solution when the extract/reference has been added at a particular level, and $A_{control}$ is the absorbance of the $DPPH^{\bullet}$ solution without extract added. All analyses were run in triplicate and mean values were calculated.

2.5. Determination of the reducing power

The reducing power of the leaf extracts was tested according to the method described by Siddhuraju, Mohan and Becker (2002). One-half ml of methanol solution from each extract in different concentrations（0.05, 0.10, 0.15, 0.20 and 0.25 mg/ml）as well as gallic acid were mixed with 2 ml of phosphate buffer (0.2 M, pH 6.6) and 2 ml of aqueous potassium ferricyanide (1%). Afterwards, the mixture was incubated at 50 ^{o}C for 20 min and then 2 ml of 10% trichloroacetic acid was added. The mixture was centrifuged at 3000 rpm for 10 min. Five ml of the upper layer of the solution was mixed with 5 ml of distilled water and 0.5 ml of aqueous $FeCl_3$ (1%). The absorbance was read at 700 nm. Analyses were triplicated.

2.6. Antioxidant activity against lipid peroxidation

The antioxidant activity of the 90% aqueous ethanol extracts against lipid peroxidation was measured using the thiocyanide method as described previously by Kikuzaki and Nakatani (1993). Each extract (0.5 mg) in 0.5 ml of absolute ethanol was mixed with 0.5 ml absolute ethanol solution of

linoleic acid (2.51%), 1 ml of 0.05 M phosphate buffer (pH 7), and 0.5 ml of distilled water. The reaction mixture was then incubated in the dark at 40 °C for autoxidation. Aliquots of 0.1 ml were taken at every 12 h during incubation and the degree of oxidation was measured by sequentially adding ethanol (9.7 ml, 75%), aqueous ammonium thiocyanate (0.1 ml, 30%) and aqueous ferrous chloride (0.1 ml, 0.02 M in 3.5% HCl). After the mixture has stood for 3 min, the peroxide value was determined by monitoring absorbance at 500 nm until the absorbance of the control (containing all reagents except the test sample) reached the maximum. Gallic acid was employed as a reference and the antioxidant activity was expressed as percent inhibition relative to control using the equation:

Lipid peroxidation inhibition (%) = [1 – (sample absorbance at 48 h – sample absorbance at 0 h)/(control absorbance at 48 h – control absorbance at 0 h)] × 100

2.6. Statistical analysis

The statistical analyses were performed using the statistical package SPSS (Statistical Package for Social Science, SPSS Inc., Chicago, IL). Analyses of variance were performed by ANOVA procedures and significance of each group was verified with one-way analysis of variance followed by Duncan's multiple range test ($P < 0.05$). The 50% inhibitory concentration (IC_{50}) was calculated according to Concentration-Effect regression line. Correlation analysis was carried out to determine the relationship between the antioxidant activity and the TPC or flavonoid content. Values obtained are means of three replicate determinations ± standard deviation.

3. Results and discussion

3.1. Total phenolic and flavonoid contents

The grouped bar chart (Fig. 1) indicates the extractable total phenolic and flavonoid levels in the dried leaf samples. The TPC was determined from the regression equation of the calibration curve

obtained from gallic acid (y = 0.0890x + 0.0037, r > 0.999). The content of flavonoid was determined from the regression equation of the calibration curve obtained from rutin (y = 0.0115x + 0.0033, r > 0.999). The result showed that *F. virens* var. *sublanceolata* possesses the highest levels of total phenolics (17.44 mg/g) and flavonoids (3.87 mg/g), while the lowest amounts of total phenolics and flavonoids were found in *F. racemosa* (7.83 mg/g) and *F. oligodon* (1.05 mg/g), respectively.

In this research, all of the dry leaves had a content of 7.83 – 17.44 mg/g phenolics and 1.05 – 3.87 mg/g flavonoids. The values are comparable to those of the root extract of *F. racemosa* (Sharma & Gupta, 2008) and the bark, fruits and leaf extracts of *F. microcarpa* L. f. (Ao, Li, Elzaawely, Xuan, & Tawata, 2008). Additional work is necessary to determine the specific chemical constituents of the leaf extracts mentioned above. Li, Leach, Myers, Lin, Leach and Waterman (2004) and Veerapur et al. (2009) have previously reported that the specific natural antioxidant compounds in the ethanol extracts of *F. racemosa* include racemosic acid, bergenin, tannins, kaempferol, rutin, bergapten, psoralenes, ficusin, coumarin and phenolic glycosides.

3.2. Free radical scavenging capacity

The abilities for each concentration of the extract samples to scavenge $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radicals are shown in Fig. 2 and Fig. 3, respectively. These extracts significantly inhibited the activities of $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radicals in a dose-dependent manner ($P < 0.05$) and almost complete inhibition (97.68%) of $ABTS^{\bullet+}$ radicals was observed for 0.5 mg/ml of young leaf extract of *F. virens* var. *sublanceolata*. Similar $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ free radical scavenging activities have previously been documented for the ethanol extract of *Ficus carica* L. fruits and methanol extract of *Ficus microcarpa* L. fil. leaves (Ao et al., 2008; Yang, Yu, Ou, Ma, Liu, & Ji, 2009).

The IC_{50} values were calculated and tabulated in Table 1 to facilitate the comparison of the free

radical scavenging activities (FRSA) of different samples. The IC_{50} value is the concentration of the samples required to scavenge 50% of the free radicals present in the system. It was calculated using the Concentration-Scavenging activity curve ($r > 0.99$). Lower IC_{50} implies a higher FRSA. As shown in Table 1, the IC_{50} of *F. virens* var. *sublanceolata* and *F. auriculata* extracts were lower than those of other species, suggesting that both $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radical scavenging by extracts from *F. virens* var. *sublanceolata* and *F. auriculata* were more effective than other species. The gallic acid reference displayed excellent FRSA (data was not shown in Fig. 2 and Fig. 3) and its IC_{50} values were computed (Table 1). In the report by Orhan, Kartal, Abu-Asaker, Senol, Yilmaz and Sener (2009), it was also shown that gallic acid exhibited a particular high radical scavenging activity compared with plant extracts.

3.3. Reducing power

The relative ferric reducing power of extracts from young leaves of the seven *Ficus* species as well as gallic acid reference are tabulated in Table 2. A higher absorbance of the reaction mixture indicated greater reducing power. Various concentrations of each sample were used for the assay and all of the samples appeared to exert effective reducing power in a dose-dependent manner ($P < 0.05$). However, reducing power exhibited by the extracts from *F. virens* var. *sublanceolata* and *F. auriculata* was again noteworthy under these experimental concentrations. Similar observations of antioxidant properties in terms of dose dependency and reducing power activity have been reported for solvent extracts of the aerial root of *F. bengalensis* L. and the stem bark of *F. racemosa* L. (Manian, Anusuya, Siddhuraju, & Manian, 2008). The notable reducing power of gallic acid was also documented by Orhan et al. (2009).

In the presence of the extracts, Fe^{3+} is reduced to Fe^{2+} and forms a green and blue-coloured ferrous cyanide complex, which showed maximum absorbance at 700 nm. The reducing power of a bioactive

substance is closely related to its antioxidant ability (Orhan et al., 2009). Considering the effective reducing power of the samples tested, the antioxidant compounds of all the extracts should function as good electron and hydrogen-atom donors and therefore be able to terminate radical chain reaction by converting free radicals and reactive oxygen species to more stable products (Siddhuraju et al., 2003).

3.4. Peroxidation inhibition activity in a linoleic acid system

The extracts from *F. virens* var. *sublanceolata*, followed by *F. callosa* and *F. auriculata*, conferred substantial inhibition against the peroxidation of linoleic acid, whereas *F. virens* var. *verins* and *F. oligodon* offered less effective inhibition as depicted in Fig. 4 (values for *F. vasculosa* and *F. racemosa* are not shown). Gallic acid was also compared along with the extracts at a concentration of 8 µg/ml. All of the five species' extracts showed excellent inhibition at 1 mg/ml in the range of 41.40 – 83.80% after incubation for 48 hrs. Peroxidation inhibition efficacy has also been reported for solvent extracts of the aerial root of *F. bengalensis* L. and the stem bark of *F. racemosa* L. (Manian et al., 2008).

Some natural antioxidants from plants have been shown to prevent lipid peroxidation-mediated cell injury. The lipid peroxidation inhibition activities of our plant samples expose the complexity of the extracts composition (aqueous versus hydrophobic compounds) as well as potential interaction between the extract and emulsion components, oil, water or lipid-air interfaces (Koleva, van Beek, Linssen, de Groot, & Evstatieva, 2002). However, the inhibition effect of all the extracts in our study was significantly lower than the gallic acid reference at the specified experimental concentrations. This might partly be due to the fact that gallic acid (hydrophobic antioxidant) is extraordinarily effective in an oil-in-water emulsion system. By moving to the oil phase, the hydrophobic antioxidants readily attain adequate concentrations to protect oil at the oil-water interface (Frankel & Meyer, 2000).

3.5. Correlation analysis

Phenolics are important nutritional ingredients in edible plants and are confirmed to possess a wide range of therapeutic uses. Several studies suggest that increased dietary intake of natural phenolic antioxidants can decrease the risk of coronary heart disease (Middleton, Kandaswami, & Theoharides, 2000; Stampfer, Hennekens, Manson, Colditz, Rosner, & Willett, 1993) because of their antioxidant activities, which mainly arise from the presence of hydroxyl groups. The flavonoids are a large family of low molecular weight polyphenolic compounds and it has long been recognized that many flavonoids widely distributed in edible plants are strong antioxidants which possess effective ROS scavenging capacity due to their phenolic hydroxyl groups (Cao, Sofic, & Prior, 1997). These compounds can modulate lipid peroxidation involved in atherogenesis, thrombosis and carcinogenesis, and their known properties include strong antioxidant activity, inhibition of hydrolytic and oxidative enzymes as well as anti-inflammatory action (Siddhuraju et al., 2003).

In our study, the results obtained by correlation analysis indicate that the content of the extractable total phenolic have a statistically significant influence on the observed antioxidant capacities determined by different systems ($P < 0.01$), and the $ABTS^{\bullet+}$ radicals scavenging effects ($P < 0.05$), ferric reducing power ($P < 0.01$) and peroxidation inhibition properties ($P < 0.05$) of the leaf extracts correlate well with their contents of extractable flavonoids. Research on the leaf extracts of *F. carica* L. showed similar results (Konyalioglu, Saglam, & Kivcak, 2005). While an insignificant relationship was observed between the flavonoid content and the $DPPH^{\bullet}$ radical scavenging activity, this might partly be attributed to the presence of glycoside in the flavonoids that could decrease the $DPPH^{\bullet}$ radical scavenging ability by affecting the donation of hydrogen (vonGadow, Joubert, & Hansmann, 1997). On the other hand, other compounds besides phenolics and flavonoids may contribute to these activities. Take *F. auriculata* as an example, the young leaves of *F. auriculata* contain considerably high amount

of selenium and it is known that selenium acts as an integral constituent of the antoxidative enzyme glutathione peroxidase (GSH-Px), which detoxifies hydrogen peroxide and organic lipid peroxides. The extracts' effective antioxidant activities may also attribute to their higher vitamin E contents compared with regular vegetables (Xu et al, 2005). In addition, the observed total antioxidant effect may be higher than the simple summation of antioxidant donation of every individual compound because of synergetic effects (Dasgupta & De, 2004).

Significant correlations were also observed between antioxidant capacities determined by different systems ($P < 0.01$), indicating that these four methods have satisfactory correlations for the examination of antioxidants.

4. Conclusions

For the first time, we evaluated the antioxidant effects of the edible young leaves of *F. virens* var. *sublanceolata*, *F. auriculata, F. vasculosa, F. callosa, F. virens* var. *verins, F. racemosa* and *F. oligodon* along with their total phenolic and flavonoid contents. Our results showed that the edible young leaves of the seven *Ficus* species possess abundant antioxidants at various concentrations, and the ethanol extracts of *F. virens* var. *sublanceolata* and *F. auriculata* showed considerable high antioxidant potential compared with other species tested.

Recently, seven different antioxidant compounds, including protocatechuic acid, chlorogenic acid, catechin, epicatechin etc., have been reported in methanolic extracts of the stem bark of *Ficus microcarpa* L. fil. All the reported compounds showed strong antioxidant activity (Ao, Higa, Ming, Ding, & Tawata, 2010). Joseph et al. (2010) overviewed the phytopharmacological properties of *F. racemosa* and reported much evidence on its considerable antioxidant ability. Meanwhile there has been no previous study of antioxidant effects of the other six species examined here. Some examples,

such as young leaves of *F. virens* var. *sublanceolata* and *F. auriculata* have however been found to be more potent than *F. racemosa*. Hence, further research is essential to establish the antioxidant potential of some underexploited *Ficus* species, especially those being used traditionally for pharmacological or dietetic purposes. The one with considerable nutrient content and antioxidant potential should be given preferential consideration for functional food or local special products development, which aims to meet the demands for pollutant free, health improving and house special dishes of the residents and millions of tourists.

Acknowledgements

The authors gratefully acknowledge the financial support by the Chinese Academy of Sciences for establishment of "Tropical medicinal plant resource center" (KSCX2-YW-R-172) and "Wild edible plant collection" in Xishuangbanna Tropical Botanical Garden. Species identification was accomplished by Ms. Xiao Chunfen and is greatly appreciated. The authors also wish to thank Dr. Douglas Schaefer and Beng Kingsly Chuo for their critical reading and language editing during the preparation of this manuscript.

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354 Fig. 1 Levels of total phenolic and flavonoid present in young leaves of the seven *Ficus* species. Values

355 are the mean of triplicate determinations ± SD

356 **FVS**, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FV**, *F. vasculosa*; **FA**, *F. auriculata*; **FVV**, *F. virens*

357 var. *verins*; **FR**, *F. racemosa*; **FO**, *F. oligodon*. For total phenolics, results are expressed as mg of gallic

358 acid equivalent per g of dry material. For flavonoids, results are expressed as mg of rutin equivalent per

359 g of dry material. The bars with different lowercases are significantly different ($P < 0.05$).

Fig. 2 $ABTS^{\bullet+}$ radical scavenging activities of young leaf extracts of the seven *Ficus* species. Values are the mean of triplicate determinations ± SD **FVS**, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FV**, *F. vasculosa*; **FA**, *F. auriculata*; **FVV**, *F. virens* var. *verins*; **FR**, *F. racemosa*; **FO**, *F. oligodon*. The bars with different letters are significantly different ($P < 0.05$).

Fig. 3 DPPH$^{\bullet}$ radical scavenging activities of young leaf extracts of the seven *Ficus* species. Values are the mean of triplicate determinations ± SD **FVS**, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FV**, *F. vasculosa*; **FA**, *F. auriculata*; **FVV**, *F. virens* var. *verins*; **FR**, *F. racemosa*; **FO**, *F. oligodon*. The bars with different letters are significantly different ($P < 0.05$).

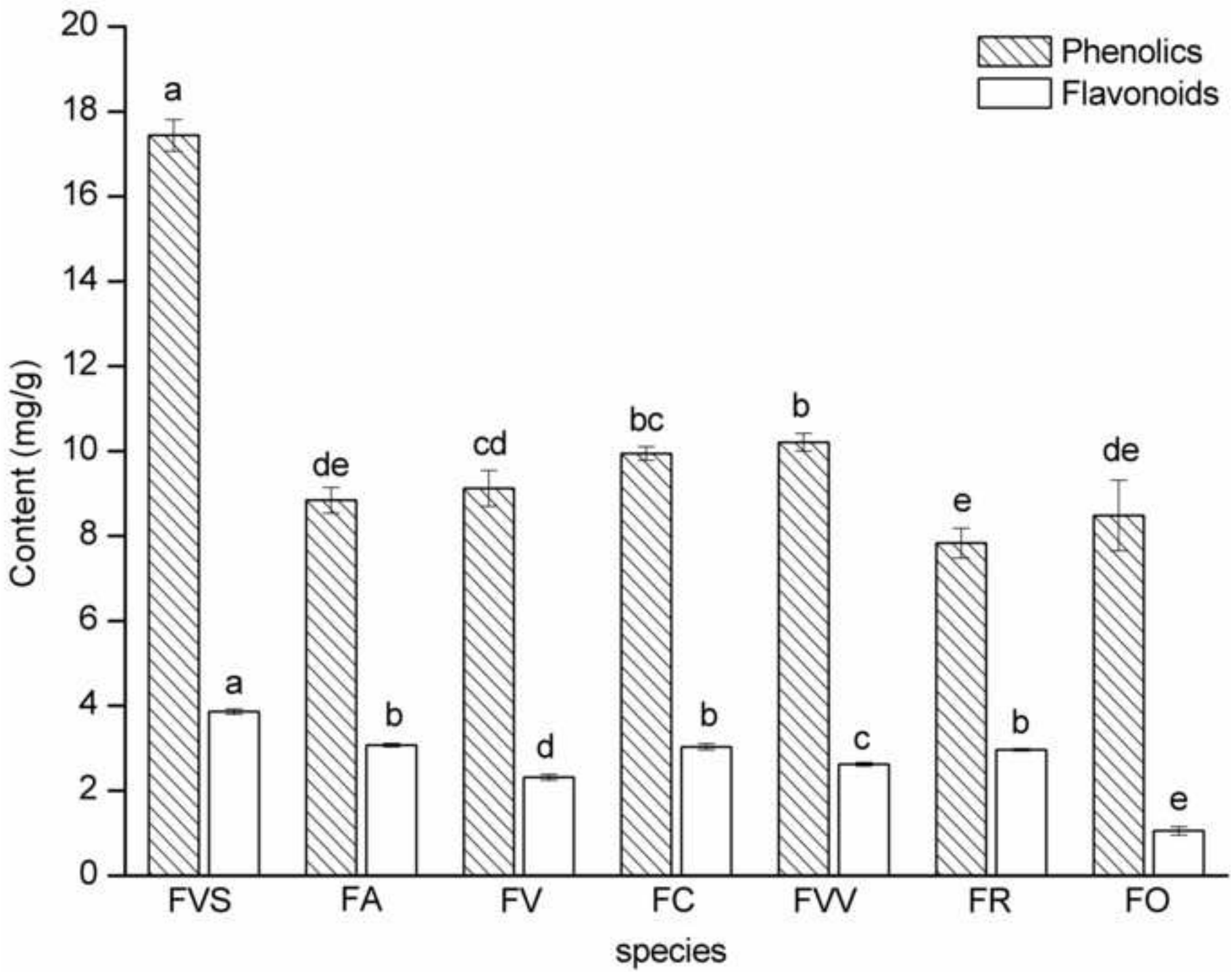
370 Fig. 4 Peroxidation inhibition by young leaf extracts of five *Ficus* species as well as gallic acid. Values

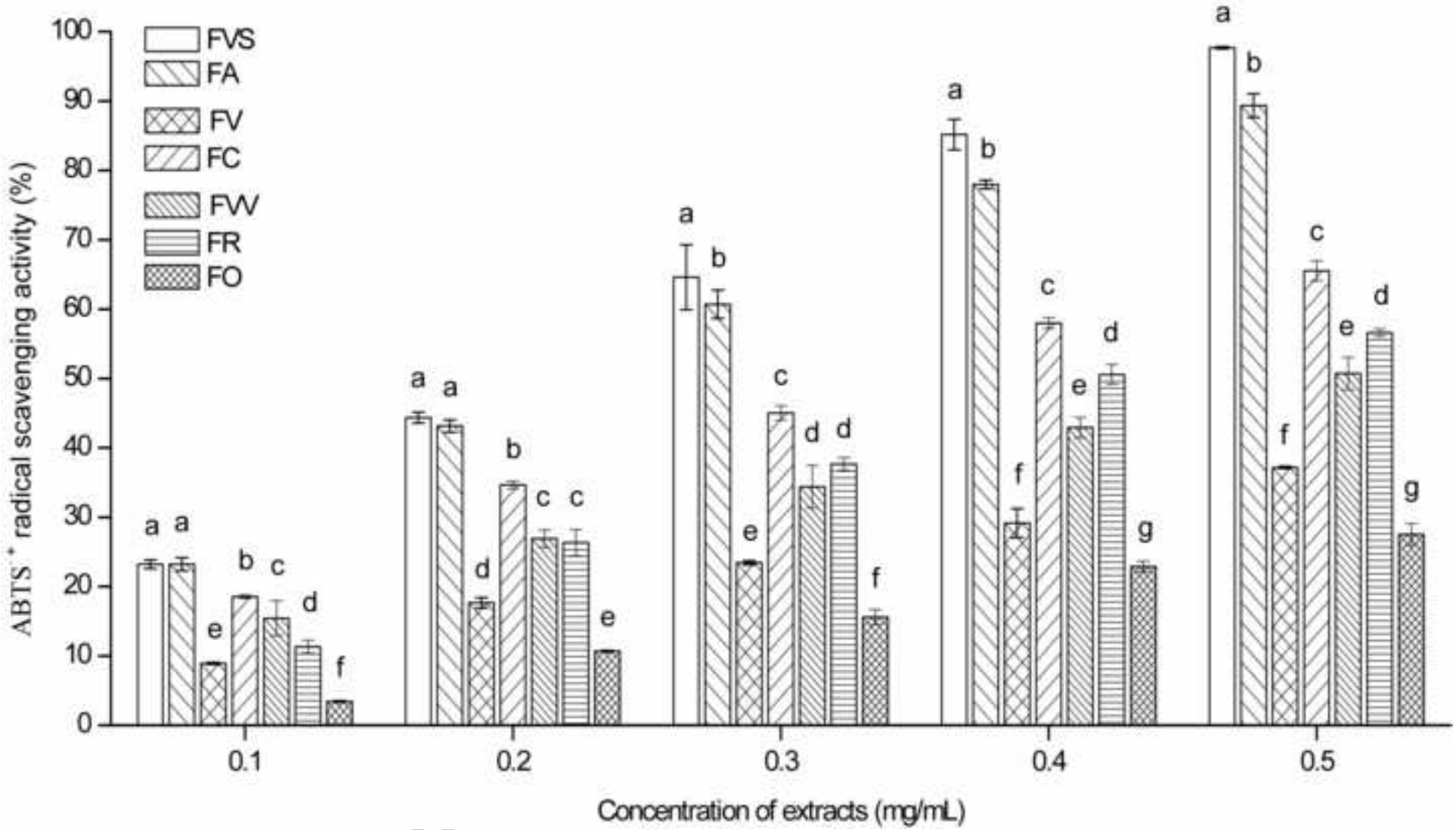
371 are the mean of triplicate determinations ± SD

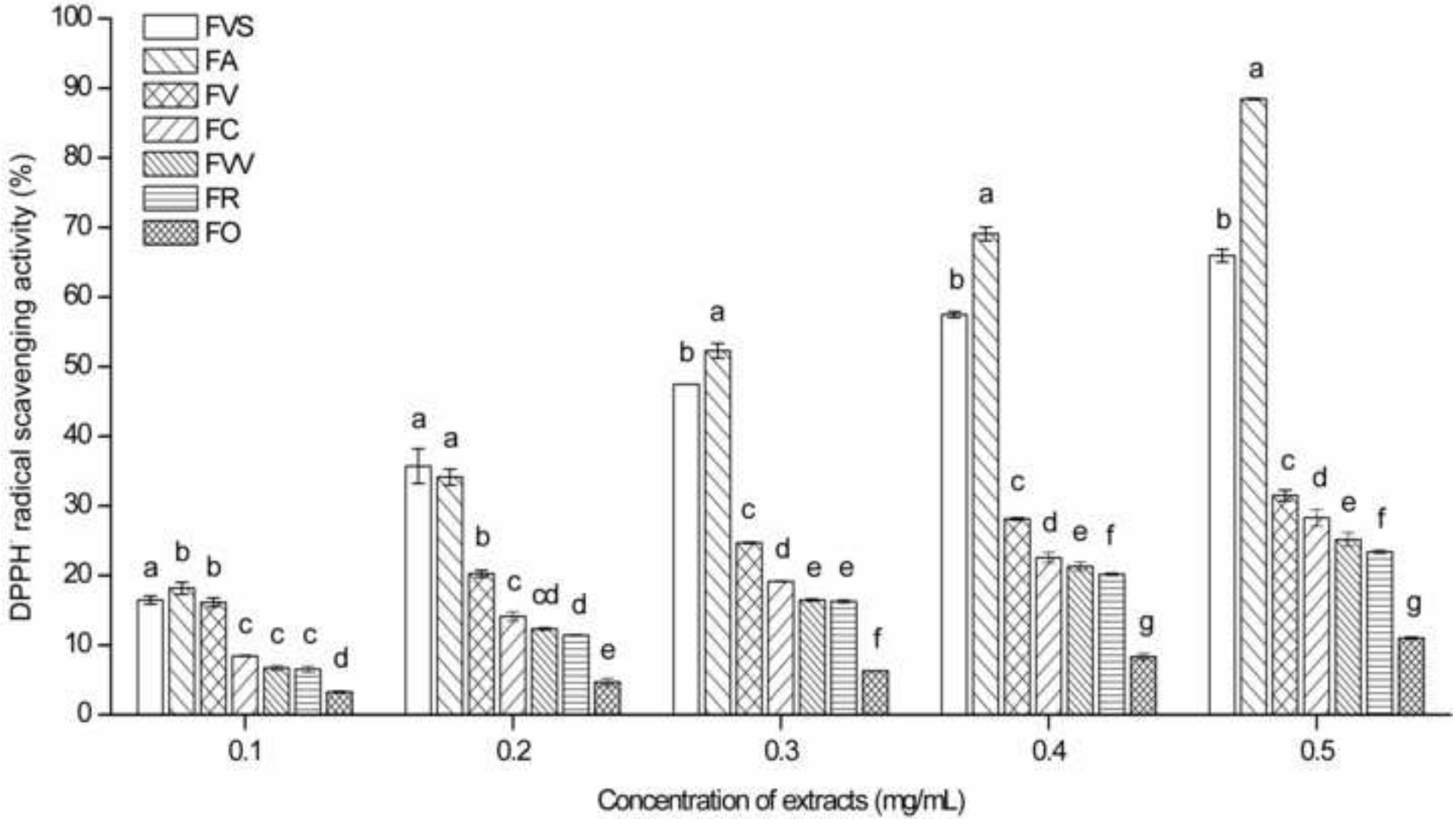
372 **FVS**, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FA**, *F. auriculata*; **FVV**, *F. virens* var. *verins*; **FO**, *F.*

373 *oligodon*. Extracts at a concentration of 1 mg/ml. Gallic acid at a concentration of 8 μg/ml. The bars

374 with different letters are significantly different ($P < 0.05$).







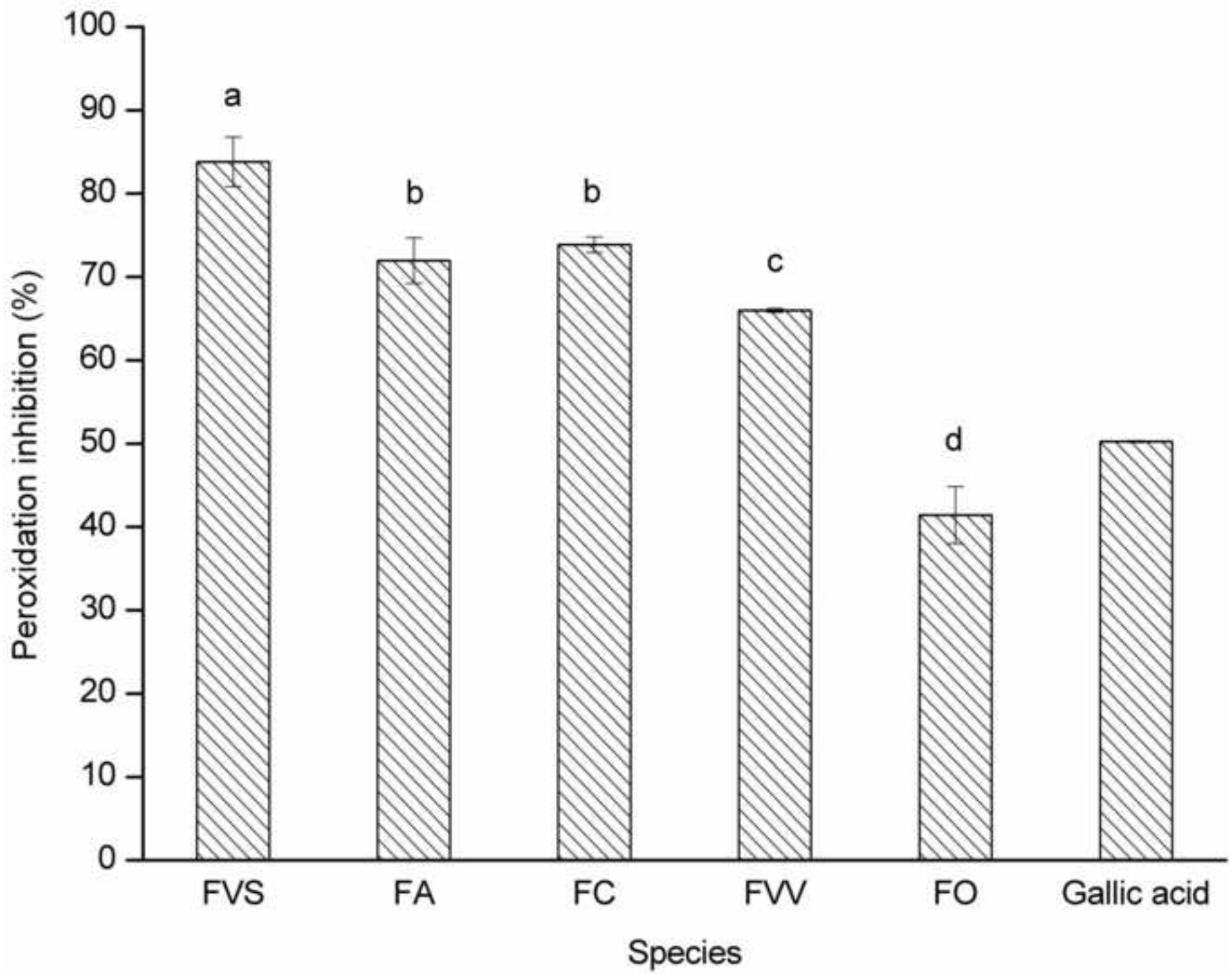


Table 1

Comparison of the IC_{50} values for radical scavenging assays of young leaf extracts of the seven *Ficus* species as well as gallic acid

Species	IC_{50} values of each free radical scavenging assay (mg/ml)	
	$ABTS^{\bullet+}$	$DPPH^{\bullet}$
FVS	0.23	0.34
FA	0.25	0.29
FV	0.69	0.97
FC	0.35	0.95
FVV	0.48	1.03
FR	0.42	1.11
FO	0.86	2.54
Gallic acid [A]	2.76	5.04

FVS, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FV**, *F. vasculosa*; **FA**, *F. auriculata*; **FVV**, *F. virens* var. *verins*; **FR**, *F. racemosa*; **FO**, *F. oligodon*.

[A] IC_{50} values in μg/ml.

380 **Table 2**

381 **Ferric reducing power of young leaf extracts of the seven *Ficus* species as well as gallic acid**

Extract concentration [A]	Absorbances							Gallic acid concentration [B]	Absorbances
	FVS	FA	FV	FC	FVV	FR	FO		
0.05	0.13± 0.003 a	0.11± 0.006 b	0.07± 0.005 d	0.08± 0.005 c	0.06± 0.001 d	0.05± 0.001 e	0.04± 0.001 f	1.6	0.12±0.000
0.10	0.25± 0.006 a	0.19± 0.002 b	0.12± 0.001 e	0.15± 0.003 c	0.13± 0.001 d	0.11± 0.003 e	0.08± 0.003 f	3.2	0.21±0.008
0.15	0.38± 0.000 a	0.28± 0.004 b	0.16± 0.002 e	0.22± 0.003 c	0.20± 0.004 d	0.16± 0.001 e	0.13± 0.005 f	4.8	0.30±0.009
0.20	0.52± 0.013 a	0.36± 0.011 b	0.22± 0.005 e	0.28± 0.002 c	0.25± 0.006 d	0.21± 0.006 e	0.18± 0.003 f	6.4	0.41±0.008
0.25	0.66± 0.021 a	0.45± 0.008 b	0.26± 0.001 d	0.33± 0.002 c	0.32± 0.003 c	0.26± 0.001 d	0.22± 0.004 e	8.0	0.53±0.011

382 **FVS**, *F. virens* var. *sublanceolata*; **FC**, *F. callosa*; **FV**, *F. vasculosa*; **FA**, *F. auriculata*; **FVV**, *F. virens* var. *verins*; **FR**, *F. racemosa*; **FO**, *F.*

383 *oligodon*. Values are means of triplicates ± SD at 700 nm. Means with different letters in the same row are significantly different ($P < 0.05$).

384 [A] Concentrations in mg/ml. [B] Concentrations in µg/ml.

385

386 **Highlights**

387 ► Young leaves of seven *Ficus* species contain considerable phenolics and flavonoids ► Extracts of the
388 young leaves exhibit excellent *in vitro* antioxidant capacities ► Phenolics and flavonoids act as
389 important antioxidants ► Young leaves of two *Ficus* species show notable antioxidant potential

390