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Antioxidant Activity of Ethanolic Extract of *Bauhinia scandens*

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ABSTRACT

Recently, much attention has been focused on the exploration of the ethnomedicine containing the antioxidant property for limiting the harmful effects of excessive reactive oxygen species (ROS) generation in the body. *Bauhinia scandens* has been reported to exert antioxidant property however which part of the plant has not been fully elucidated yet. The study aimed to investigate the antioxidant activity of *Bauhinia scandens* especially in the bark and leaf parts. The antioxidant activity of this plant was measured using 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay method. The inhibitory concentration 50 (IC_{50}) of each sample was calculated to show the antioxidant activity. The IC_{50} value of *Bauhinia scandens* barks and leaves ethanolic extract were 34.77 µg/ml and 113.50 µg/ml respectively and standard ascorbic acid (as positive control) IC_{50} was 79.57 µg/ml. To our knowledge, this is the first study to show *Bauhinia scandens* barks ethanolic extract exerts higher antioxidant activity compared to ascorbic acid. This activity may relate to the specific phytochemicals in *Bauhinia scandens.*

Key words *: Antioxidant activity, Bauhinia scandens, DPPH assay method, Ethanolic extract of barks, Ethanolic extract of leaves*

Introduction

Ethnomedicine is a medicinal study by using bioactive compounds from plants in treating some diseases and it is traditionally practiced by the ethnic communities who especiallyhave a limited access to obtain modern medicine. Recently, much attention has been focused towards the exploration of the ethnomedicine containing the strong antioxidant properties for reducing the harmful effects of excessive production of reactive oxygen species (ROS) molecules in the body. Many investigations of antioxidant potential from natural sources have been reported with various plants(Jain *et al.*, 2019; Prakash *et al.*, 2007) such as *Erythrinavariegata* L. (Hemmalakshmi *et al.*, 2016); *Bauhinia variegate* (Sawhney *et al.*, 2012; Sharma *et al.*, 2015; Tripathi *et al.*, 2019); *Bauhinia purpurea* (Urmi *et al.*, 2013) and

Bauhinia vahlii Wight and Arn. (Sowndhararajan and Kang, 2013). The natural compound of *Bauhinia* genus had been employed in various diseased animal model including diabetes mellitus, infection, cancer and chronic inflammation (Filho, 2009). Ethanolic or methanolic extract of *Bauhinia* genus have also been reported to give beneficial effect as medicinal remedies and to exert medicinal properties as an anti-diabetic (*Bauhinia forficata, Bauhinia monandra, Bauhinia divaricata, Bauhinia variegata*), anti-microbial (*Bauhinia splendens, Bauhinia racemosa, Bauhinia variegata*), anti-fungal (*Bauhinia forficata, Bauhinia rufescens*), anti-inflammation and analgesic (*Bauhinia scandens, Bauhinia guianensis*), anti-spasmodic (*Bauhinia microstachya, Bauhinia racemosa*) and anti-oxidant (most of the Bauhinia genus)(Filho, 2009; Hazra and Chatterjee, 2008; Sharma *et al*., 2015). Many studies have reported that phytochemical or secondary metabolite products from plants such as flavonoids, polyphenols, terpenes, alkaloids plays important roles in the antioxidant properties of Bauhinia genus (Amarowicz, 2007; Brunetti *et al*., 2013; Graßmann, 2005; Pietta, 2000). For example, the methanolic extract of *Bauhinia vahlii* leaves exerts strong antioxidant potential at least in part due to its antioxidant-related phytochemicals compound including total tannins, phenolics, and flavonoids (Sowndhararajan and Kang, 2013).

Bauhinia scandens L. belonging to the Leguminosae family is known as 'chain tree' and distinctively dispersed in Indonesia including Semarang, Central Java. Its morphologic characteristics have been described previously in our publication(Lianah, 2016; Lianah *et al*., 2021). In summary, *Bauhinia scandens* is liana with ornamental value; the stem forms into a 'monkey ladder' when older; the fruits are pea shaped with 1 to 2 seeds. Apart from Jeromini *et al.* (2020) who studied optimal growing medium for growing *Bauhinia scandens* seedlings and Jeromini *et al.* (2021) who reported the methods to overcome seed dormancy, very limited studies have been conducted on propagation and culture of this species.According to previous phytochemical screening, the ethanolic extract of its leaves contained some phytochemicals such as phenols, flavonoids, saponins, tannins, alkaloids and steroids which are widely known to have strong relation with medicinal anti-oxidant properties (Lianah *et al*., 2021). In addition, according to preliminary cytotoxic activity evaluation against HeLa and T47D cell lines, the ethanolic extract of the *Bauhinia scandens* leaves had potential to be anti-cancer agent (Lianah *et al*., 2021). Growth reduction of HeLa and T47D cell lines may be related with anti-

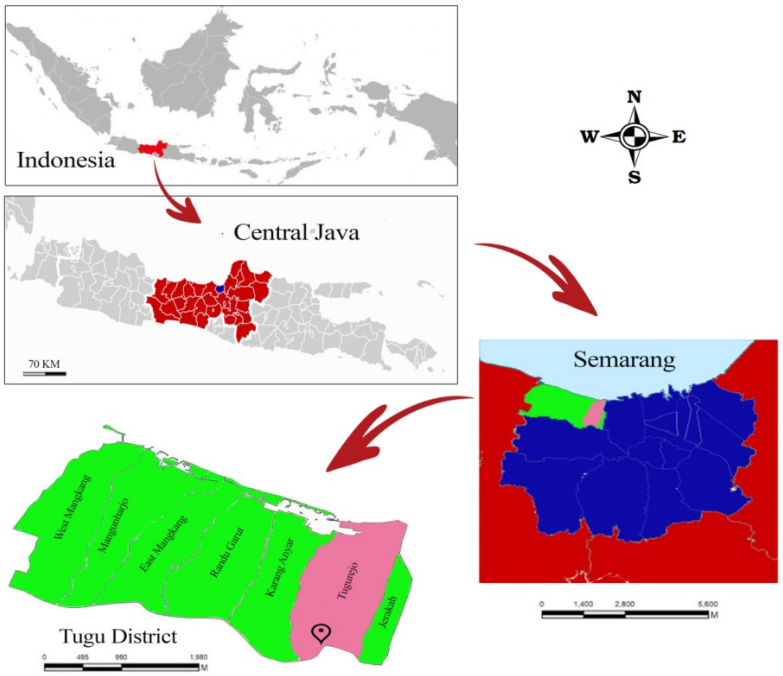

Fig. 1. Location of collecting sample at cemetery of Tugurejo, Tugurejo District, Semarang, Central Java, Indonesia (6° 58' 55.7904'' S, 110° 21' 2.3472'' E).

oxidant capacity and phytochemical function. It has been previously reported that the ethanolic extracts of *Bauhinia scandens* contained high amounts of polyphenol compounds and had an antioxidant activity with IC_{50} value of 13.5 µg/ml whereas standard ascorbic acid as positive control had an IC_{50} value of 8.25 µg/ml (Hossain *et al.*, 2016), however, which parts of the *Bauhinia scandens* exert antioxidant property have not been fully elucidated yet. Therefore, in this study, we investigated the antioxidant activity of the ethanolic extracts of *Bauhinia scandens* leaves and barks.

Materials and Methods

Preparation of Sample

The fresh bark and leaves of *Bauhinia scandens* were collected on November 2020 from the cemetery at Tugurejo District, Semarang, Indonesia (Figure 1). The plant was stored and then identified in Herbarium Bogoriense, Research Center for Biology, Indonesian Institute of Science (LIPI), Bogor, Indonesia. The samples were cleaned and dried for 2 weeks in room temperature. The samples (10 grams) were macerated in 96% ethanol for 24 hours and then stirred periodically. The filtrate was re-macerated or rinsed in 96% ethanol to obtain optimal ethanol extract. The filtrate from the maceration was evaporated at 45-50 °C using rotary evaporation. The stock solution of the ethanolic extract was prepared for antioxidant testing by dissolving it in 96% ethanol. Then, the ethanolic extract solution of samples was made with some concentrations (6.25; 12.5; 25; 50; 100 µg/ml).

Antioxidant activity test

The antioxidantactivity of the leaves and barks of *Bauhinia scandens* was measured by using 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay method described by Jan *et al.* (2013) with modification. The stock solution of DPPH (2.4 mg in 100 ml methanol) was prepared and stored at 20 °C until needed. The test mixture contained 3 ml DPPH working solution and 0.1 mL of a sample at different concentrations (6.25µg/ml-100 µg/ml). After incubation at 37°C for 15 min in dark, the absorbance of the reaction mixture was measured at λ 517 nm using a UV-Visible Spectrophotometer. The same treatment was carried out for negative control solution (DPPH without sample extract) and positive control solution (ascorbic acids). The presence of antioxidant inhibited DPPH free radicals by acting as a hydrogen donor shown by discoloration of solution from violet to pale yellow. Measurement was carried out in triplicate. The percentage of inhibition activity was calculated using the following equation (Jan *et al.*, 2013).

$$\% \text{ Inhibition} = \frac{(\text{Abs. control} - \text{Abs. Sample})}{\text{Abs. control}} \times 100$$

The inhibitory concentration 50 (IC_{50}) is a quantitative measurement that indicates how much of a particular inhibitory substance is required to inhibit a biological component by 50%. This IC_{50}value is widely used to measure the antioxidant activity of test samples. It is calculated as the concentration of antioxidants needed to scavenge the DPPH radicals by 50% therefore the lower the IC_{50} value the higher antioxidant activity (Rivero-cruz *et al.*, 2020). The antioxidant activity of ascorbic acid was used as positive control. When a compound (as hydrogen donor) is added to a DPPH solution, it will obtain hydrazine which is indicated with a change in color from violet to pale yellow (Formagio *et al.*, 2014).

Data analysis

The inhibition percentage value was plotted in a graphic. The IC_{50} value for the extracts was determined by linear regression analysis to generate formula (y = ax + b) using Microsoft Excel, which was 'y' as an inhibition percentage and 'x' as extract concentration.

Results and Discussion

We found that the ethanolic extracts of *Bauhinia scandens* barks and leaves and also ascorbic acid showed DPPH radical scavenging activity as well as antioxidant activity indicated by inhibition percentage of DPPH radicals. This inhibition percentage of both samples and ascorbic acids increased in a concentration-dependent manner based on DPPH test (Figure 2). Based on linear regression analysis, we found that the ethanolic extract of *Bauhinia scandens* barks had the IC_{50} value of 34.77 µg/ml. This IC_{50} value was lower than IC_{50} value in the ethanolic extract of *Bauhinia scandens* leaves and standard ascorbic acid (as positive control) with IC_{50} values of 113.5 µg/ml and 79.57 µg/ml, respectively (Table 1).

Table 1. IC_{50} of ethanolic extracts of *Bauhinia scandens* bark and leaves, and ascorbic acid

Samples	IC_{50} (µg/ml)
Ethanolic extract of *Bauhinia scandens* barks	34.77
Ethanolic extract of *Bauhiniascandens* leaves	113.5
Ascorbic acids (positive control)	79.57

Discussion

DPPH tests have been widely used to measure the ability of a compound as a free-radical scavenger or a hydrogen donor and to show the antioxidant activity of plant extracts (Jain *et al.*, 2019; Kedare and Singh, 2011; Prakash *et al.*, 2007). The DPPH is a lipophilic and relatively stable free radical with a maximum absorption at λ 517 nm which can be readily scavenged by accepting an electron or hydrogen to form a stable diamagnetic molecule (Kedare and Singh, 2011). The most prominent finding in our study is that the ethanolic extract of *Bauhinia scandens* barks had the IC_{50} value of 34.77 µg/ml, significantly lower than the IC_{50} value of *Bauhinia scandens* leaves ethanolic extract standard ascorbic acid. According to the extent of our knowledge, this is the first study to show different antioxidant properties of *Bauhinia scandens* plants parts. It is generally known that the lower the IC_{50} value then the higher the antioxidant activity of the compounds (Kedare and Singh, 2011). In our study we have shown that ethanolic extract of *Bauhinia scandens* barks had lower IC_{50} than its leaves extract and ascorbic acidthus the antioxidant activity in the *Bauhinia scandens* barks ethanolic extract was higher than its leaves and ascorbic acids. This IC_{50} value of ascorbic acid was different in other studies, for example, about 33.77 µg/ml (Urmi *et al.*, 2013) and 8.25 µg/ml (Hossain *et al.*, 2016) due to varied experimental conditions. This IC_{50} values in both of these sample extracts are quite larger compared with other plant extracts, for example, the IC_{50} value of the ethanolic extract of *Bauhinia scandens* (13.5 µg/ml) (Hossain *et al.*, 2016) and the ethanolic extract of *Bauhinia variegata* (29.3 µg/ml) (Bhatia *et al.*, 2011) however, they are low enough to the methanolic extract of *Bauhinia racemosa* barks (152.29 µg/ml) (Kumar *et al.*, 2005). The different solvent types had an influential role in the yield of extraction and affected biological activity plant parts (Sultana *et al.*, 2009; Truong *et al.*, 2019). For example, the methanol extract of *Moringaoleifera* had the highest activity with the lowest IC_{50} value among the other leaves extracts (the IC_{50} values of methanol < ethyl acetate < n-hexane < dichloromethane extracts) (Fitriana *et al.*, 2016). According to Truong *et al.* (2019), methanol was recommended as the optimal solvent to obtain a high content of phytochemical constituents, high antioxidants and in vitro anti-inflammatory constituents from the *Severiniabuxifolia* branches (the IC_{50} values of methanol < ethanol < chloroform < acetone < dichloromethane extracts). Before using ethanol as solvent, we had tried to use

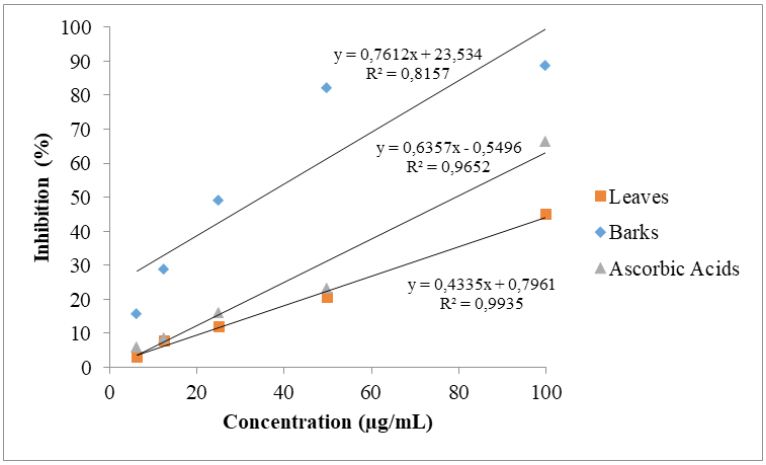

Fig. 2. Linear regression analysis for % inhibition of ethanolic extract of *Bauhinia scandens* barks and leaves and also ascorbic acids

methanol as solvent but the result showed that DPPH activity of the methanolic extract of *Bauhinia scandens* was very low (data are not displayed).

Antioxidants may offer a defense mechanism in preventing oxidative stress by scavenging the free radicals and inhibiting lipid peroxidation. A number of recent studies had reported that phytochemicals or secondary metabolite products from plants such as flavonoids, polyphenols, terpenes, tannins, alkaloids, etc. exhibited antioxidant activities (Amarowicz, 2007; Brunetti *et al.*, 2013; Graßmann, 2005; Pietta, 2000). The previous studies, Lianah *et al.* (2021) have reported the presence of phytochemicals with high concentration in the ethanolic extracts of *Bauhinia scandens* leaves, namely total phenols (17.57±0.098% w/w) and saponins (19.42±0.091% w/w), followed by tannins (1.24±0.035% w/w), alkaloids (1.31±0.001% w/w), and steroids (0.08±0.007% w/w). Nevertheless, a screening of phytochemicals in *Bauhinia scandens* bark has not yet been done. The observed antioxidant activity may be due to the presence of those phytochemicals. This has also been investigated before by Hossain *et al.* (2016) who reported first on antioxidant activity in the ethanolic extract of *Bauhinia scandens* because of its high amount of phenolic compounds.

Phytochemical function is linked with antioxidant capability in biological systems. Many studies have explained that phytochemicals contribute to antioxidant activity of plant. For examples,the phenolic compounds in berry fruit and *Bauhinia acuminate* exhibited antioxidant properties (Olas, 2018; Reyad-Ul-Ferdous *et al.*, 2014) whereas total flavonoids, tannins and phenolic compounds in *Psychotria* leaf extracts also exhibited antioxidant activity (Formagio *et al.*, 2014). The phenolic compounds and flavonoids can act as scavengers of singlet oxygen and free radicals (Sharma *et al.*, 2015). The role of other phenolic compounds, tannins as antioxidants also has been reported (Riedl *et al.*, 2002). In addition, flavonoid works as good free radical scavenger by some mechanisms, such as: 1) donating a hydrogen atom or by single-electron transfer; 2) by chelating or binding redox-active metal ions such as Fe^{2+} and Cu^{+} which is important for oxidation metabolism and free radical formation; 3) suppressing the enzymes associated with free radical generation such as xanthine oxidase, cyclooxygenase, lipoxygenase, protein kinase C, microsomal monooxygenase, mitochondrial succinoxidase, and NADPH oxidase; and 4) stimulating enzymatic antioxidant activity (Banjarnahor and Artanti, 2014; Heim *et al.*, 2002).

In other studies, alkaloid isolated from *Stephania rotunda* and also *Fumaria capreolata* and *Fumariabastardii* were found to be effective antioxidants (Gülçin *et al.*, 2010; Maiza *et al.*, 2007). The saponin also contributed in in scavenging free radicals, superoxide anion radical, hydrogen peroxide and ferric ions as well as explained by Olusola *et al.* (2020) in crudes methanol extract of *Zanthoxylum zanthoxyloides* leaves. From many explained studies, we can explain that phytochemicals contribute to antioxidant activity of *Bauhinia scandens.*

Conclusively, we have shown that *Bauhinia scandens* bark ethanolic extract exerts higher antioxidant property than its leaves and ascorbic acid. This result may contribute significantly in the further investigation of other properties of *Bauhinia scandens* extract especially in various model of disease.

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References

Amarowicz, R. 2007. Tannins: The new natural antioxidants? *European Journal of Lipid Science and Technology*. 109(6) : 549–551. https://doi.org/10.1002/ejlt.200700145

Banjarnahor, S. D. S. and Artanti, N. 2014. Antioxidant properties of flavonoids. *Medical Journal of Indonesia*. 23(4) : 239–244. https://doi.org/10.13181/mji.v23i4.1015

Bhatia, L., Bishnoi, H., Chauhan, P., Kinja, K. and Shailesh, S. 2011. In-vitro comparative antioxidant activity of ethanolic extracts of *Glycosmis pentaphylla* and *Bauhinia variegata*. *Recent Research in Science and Technology*. 3(7) : 1–3.

Brunetti, C., Di Ferdinando, M., Fini, A., Pollastri, S. and Tattini, M. 2013. Flavonoids as antioxidants and developmental regulators: Relative significance in plants and humans. *International Journal of Molecular Sciences*. 14(2) : 3540–3555. https://doi.org/10.3390/ijms14023540

Filho, V. C. 2009. Chemical composition and biological potential of plants from the genus *Bauhinia.*

Phytotherapy Research. 23(10) : 1347–1354. https://doi.org/doi:10.1002/ptr.2756

Fitriana, W. D., Ersam, T., Shimizu, K. and Fatmawati, S. 2016. Antioxidant activity of *Moringa oleifera* extracts. *Indonesian Journal of Chemistry*. 16(3) : 297–301. https://doi.org/10.22146/ijc.21145

Formagio, A. S. N., Volobuff, C. R. F., Santiago, M., Cardoso, C. A. L., Vieira, M. D. C. and Pereira, Z. V. 2014. Evaluation of antioxidant activity, total flavonoids, tannins and phenolic compounds in *Psychotria* leaf extracts. *Antioxidants*. 3(4) : 745–757. https://doi.org/10.3390/antiox3040745

Graßmann, J. 2005. Terpenoids as plant antioxidants. *Vitamins and Hormones*. 72 : 505–535. https://doi.org/10.1016/S0083-6729(05)72015-X

Gülçin, I., Elias, R., Gepdiremen, A., Chea, A. and Topal, F. 2010. Antioxidant activity of bisbenzylisoquinoline alkaloids from *Stephania rotunda*: Cepharanthine and fangchinoline. *Journal of Enzyme Inhibition and Medicinal Chemistry*. 25(1) : 44–53. https://doi.org/10.3109/14756360902932792

Hazra, A. and Chatterjee, P. 2008. A nontoxic antitumour compound from the leaves of *Bauhinia scandens* characterized as 1-O-alkyl glycerol by gas–liquid chromatography and evaluation of its antitumour property by Brine Shrimp bioassay. *Industrial Crops and Products*. 27(1): 39–43. https://doi.org/https://doi.org/10.1016/j.indcrop.2007.07.005

Heim, K. E., Tagliaferro, A. R. and Bobilya, D. J. 2002. Flavonoid antioxidants: Chemistry, metabolism and structure-activity relationships. *Journal of Nutritional Biochemistry*. 13(10) : 572–584. https://doi.org/10.1016/S0955-2863(02)00208-5

Hemmalakshmi, S., Priyanga, S., Vidya, B., Gopalakrishnan, V. K. and Devaki, K. 2016. Screening of the antioxidant potential of the leaves and flowers extract of *Erythrina variegata* L.: A comparative study. *International Journal of Pharmaceutical Sciences Review and Research*. 40(2) : 186–191.

Hossain, M., Niloy, S., Hosen, A., Islam, M., Islam, Z., Das, S., Hassan, M., Islam, A. and Rana, M. 2016. Antioxidant activities and HPLC-DAD based phenolic content determination of *Bauhinia scandens*. *British Journal of Pharmaceutical Research*. 14(6) : 1–9. https://doi.org/10.9734/bjpr/2016/31817

Jain, C., Khatana, S. and Vijayvergia, R. 2019. Bioactivity of secondary metabolites of various plants: A review. *International Journal of Pharmaceutical Sciences and Research*. 10(2) : 494–504. https://doi.org/10.13040/IJPSR.0975-8232.10(2).494-04

Jan, S., Khan, M. R., Rashid, U. and Bokhari, J. 2013. Assessment of antioxidant potential, total phenolics and flavonoids of different solvent fractions of *Monotheca buxifolia* fruit. *Osong Public Health and Research Perspectives*. 4(5) : 246–254. https://doi.org/10.1016/j.phrp.2013.09.003

Jeromini, T. S., da Saliva, G. Z., Martins, C. C. and Neves, B. R. 2021. Water availability and substrate in the emergency and initial development of *Bauhinia scandens* L.e. *Revista Ceres*. 68(2) : 143–148. https://doi.org/https://doi.org/10.1590/0034-737X202168020008

Jeromini, T. S., Pereira, T. S., Martins, C. C. and Da Silva, G. Z. 2020. Overcoming dormancy in *Bauhinia scandens* seeds. *Semina:Ciencias Agrarias*. 41(4) : 1189–1198. https://doi.org/10.5433/1679-0359.2020v41n4p1189

Kedare, S. B. and Singh, R. P. 2011. Genesis and development of DPPH method of antioxidant assay. *Journal of Food Science and Technology*. 48(4) : 412–422. https://doi.org/10.1007/s13197-011-0251-1

Kumar, R., Sivakumar, T., Sunderam, R., Gupta, M., Mazumdar, U., Gomathi, P., Rajeshwar, Y., Saravanan, S., Kumar, M., Murugesh, K. and Kumar, K. 2005. Antioxidant and antimicrobial activities of *Bauhinia racemosa* L. stem bark. *Brazilian Journal of Medical and Biological Research*. 38(7) : 1015–1024. https://doi.org/10.1590/S0100-879X2005000700004

Lianah, L. 2016. A Unique 'chain tree' Bauhinia (Caesalpinioideae, Leguminosae) from Pagerwunung Darupono Conservation Park, Central Java, Indonesia. *Journal of Tropical Crop Science*. 3(2) : 56–60. https://doi.org/10.29244/jtcs.3.2.56-60

Lianah, L., Khasanah, R. A. N., Pranatami, D. A. and Krisantini, K. 2021. Phytochemical screening and cytotoxic evaluation of *Bauhinia Scandens* leaf extracts using HeLa and T47D cell lines. *Biodiversitas*. 22(2): 913–919. https://doi.org/10.13057/biodiv/d220247

Maiza, B. F., Khentache, S., Bougoffa, K., Chibane, M., Adach, S., Chapeleur, Y., Max, H. and Laurin, M. 2007. Antioxidant activities alkaloid extract of two Algerian species of Fumaria: *Fumaria caapreolata* and *Fumaria bastardii. Record of Natural Products*. 1(2–3): 28–35.

Olas, B. 2018. Berry phenolic antioxidants - implications for human health? *Frontiers in Pharmacology*. 9(MAR): 1–14. https://doi.org/10.3389/fphar.2018.00078

Olusola, A. O., Elekan, A. O., Olusola, A. O., Ogidan, T. O. and Ekun, O. E. 2020. Evaluation of *in vitro* antioxidant activity of saponin-rich fraction from leaves of *Zanthoxylum zanthoxyloides*.*Environmental and Experimental Biology*. 18(3) : 175–181. https://doi.org/10.22364/eeb.18.18

Pietta, P. G. 200). Flavonoids as antioxidants. *Journal of Natural Products*. 63(7) : 1035–1042. https://doi.org/10.1021/np9904509

Prakash, D., Suri, S., Upadhyay, G. and Singh, B. N. 2007. Total phenol, antioxidant and free radical scavenging activities of some medicinal plants. *International*

Journal of Food Sciences and Nutrition. 58(1) : 18–28. https://doi.org/10.1080/09637480601093269

Reyad-Ul-Ferdous, M., Liza, F., Towshin Alam, T., Tasnim, F., Mukti, M., Khan, M. E. and Haque, T. 2014. Evaluation of potential antioxidant activity of leaves of *Bauhinia acuminate*. *Iranian Journal of Pharmaceutical Sciences*. 10(1) : 55–60.

Riedl, K. M., Carando, S., Alessio, H. M., McCarthy, M. and Hagerman, A. E. 2002. Antioxidant activity of tannins and tannin - protein complexes: assessment in vitro and in vivo. *ACS Symposium Series*. 807 : 188–200. https://doi.org/10.1021/bk-2002-0807.ch014

Rivero-cruz, J. F., Granados-pineda, J., Pedraza-chaverri, J. and Rivero-cruz, B. E. 2020. Phytochemical constituents, antioxidant, cytotoxic, and antimicrobial activities of the ethanolic extract of Mexican brown propolis. *Antioxidants*. 9(7) : 1–11.

Sawhney, S. S., Mir, M. A. and Kumar, S. 2012. Phytochemical screening and antioxidant properties of Bauhinia variegata. *International Journal of Research in Phytochemistry and Pharmacology*. 2(1) : 21–24.

Sharma, K. R., Kalauni, S. K. and Awale, S. 2015. Antioxidant, phytotoxic and antimicrobial activities of methanolic extract of *Bauhinia variegata* barks. *Journal of Institute of Science and Technology*. 20(2) : 37–41. https://doi.org/10.3126/jist.v20i2.13946

Sowndhararajan, K. and Kang, S. C. 2013. Free radical scavenging activity from different extracts of leaves of *Bauhinia vahlii* Wight and Arn. *Saudi Journal of Biological Sciences*. 20(4) : 319–325. https://doi.org/10.1016/j.sjbs.2012.12.005

Sultana, B., Anwar, F. and Ashraf, M. 2009. Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts. *Molecules*. 14(6) : 2167–2180. https://doi.org/10.3390/molecules14062167

Tripathi, A. K., Gupta, P. S. and Singh, S. K. 2019. Antidiabetic, anti-hyperlipidemic and antioxidant activities of *Bauhinia variegata* flower extract. *Biocatalysis and Agricultural Biotechnology*. 19(March) : 101142. https://doi.org/10.1016/j.bcab.2019.101142

Truong, D. H., Nguyen, D. H., Ta, N. T. A., Bui, A. V., Do, T. H. and Nguyen, H. C. 2019. Evaluation of the use of different solvents for phytochemical constituents, antioxidants, and *in vitro* anti-inflammatory activities of *Severinia buxifolia*. *Journal of Food Quality*. 2019. https://doi.org/10.1155/2019/8178294

Urmi, K. F., Mostafa, S., Begum, G., Ifa, T. and Hamid, K. 2013. Comparative antioxidant activity of different parts of *Bauhinia purpurea* L . *Biology and Medicine*. 5: 78–82.