Antioxidant activities of *Daniellia oliveri* (Rolfe) Hutch. & Dalziel and *Daniellia ogea* (Harms) Rolfe ex Holland (Caesalpiniaceae)

Olubusola O. Olaleye1*, Margaret O. Sofidiya2, Joy O. Ogba3, Wale Lasore2

1Department of Pharmacognosy, Faculty of Pharmacy, University of Lagos, Nigeria.
2Department of Biotechnology, Enzyme Technology Division, Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria.

ARTICLE INFO

Article history:
Received 20 May 2020
Revised 27 May 2020
Accepted 29 May 2020
Published 31 May 2020

ABSTRACT

*Daniellia oliveri* and *Daniellia ogea* (Caesalpiniaceae) are medicinal plants used for their various ethnomedicinal uses. Cellular damage induced by free radicals has been implicated in several diseases. Antioxidants possess the ability to protect the body from damage caused by free radical-induced oxidative stress through the inhibition of oxidation directly or indirectly. The aim of this study is to evaluate the *in vitro* antioxidant activities of the leaves and stem bark extracts of *D. oliveri* and *D. ogea* using different *in vitro* assays including hydroxyl radical scavenging, reducing power, ferrous ion (Fe2+) chelating and lipid peroxidation inhibitory activities. The total polyphenolic contents in the extracts were also determined using standard methods. All the extracts significantly (p < 0.05) inhibited hydroxyl radical in a concentration-dependent manner. The reducing power activity of the extracts were in the order; *D. oliveri* stem bark > *D. ogea* stem bark > *D. ogea* leaf > *D. oliveri*. Also, *D. oliveri* leaf had the highest lipid peroxidation inhibitory activity (IC50 = 3.71 µg/mL) compared with tocopherol and quercetin (IC50 = 4.84 and 26.58 µg/mL). The iron-chelating activity of the extracts was low compared to EDTA. Additionally, total polyphenolic content estimation revealed a considerable amount of phenolics, flavonoids and proanthocyanidins which may be responsible for the antioxidant activity exhibited by the extracts. These results provide the scientific evidence suggesting the potential antioxidant property of *D. oliveri* and *D. ogea* extracts in preventing diseases associated with oxidative stress.

**Keywords:** *Daniellia ogea*, *Daniellia oliveri*, Caesalpinioidae, antioxidant, total polyphenolic content.

Introduction

Antioxidants are an important class of substances which possess the ability to protect the body from damage caused by free radical-induced oxidative stress through the inhibition of oxidation directly or indirectly. The main attribute of antioxidants is their ability to mop up free radicals. The antioxidants in biological system can either be enzymatic or non-enzymatic. The enzymatic antioxidants include catalase (CAT), superoxide dismutase (SOD), glutathione (GSH) and peroxidase (GPx) systems, while the non-enzymatic antioxidants include reducing agents such as β-carotene, vitamin C, vitamin E, selenium and polyphenols; these all catalyze neutralization of many free radicals and therefore exert therapeutic role by being oxidized themselves. Overproduction of free radicals and the unbalanced mechanisms of antioxidant defense result in the onset of numerous chronic clinical disorders such as inflammatory diseases, ageing, asthma, diabetes mellitus, cardiovascular diseases, peptic ulcer, rheumatoid arthritis, cancer and neurodegenerative disorders. Several synthetic antioxidants are available in the market amongst which include butylated hydroxytoluene (BHT) and butylated hydroxyl anisol (BHA). However, their use is restricted because of their reported adverse health implications including carcinogenic effects and pathological damage to kidney and other vital organs.

Therefore, the development of more effective antioxidants and replacement of the synthetic compounds with natural antioxidants from medicinal plants are of research interest. Many scientific reports indicate that the antioxidant potential of medicinal plants may be related to the concentration of their phenolic compounds. These compounds are of great importance in preventing the onset and/or progression of most of the aforementioned human diseases. *Daniellia oliveri* (Rolfe) Hutch and Dalziel and *Daniellia ogea* (Harms) Rolfe ex Holland belong to the Caesalpiniaceae family. *Daniellia oliveri* is identified by its refined straight trunk and ascending branches. It can be up to a height of 9–25 m, (only a few reaching up to 45 m) with diameter of 150 – 200 cm. On the other hand, *Daniellia ogea* grows into large deciduous trees with altitude of 40–50 m, in the form of cylindrical trees, having a diameter of up to 125 cm with short, rounded buttresses at the base. In Nigeria, it is commonly found in swampy vegetation following the removal of the plantation trees. The different parts of both species have been used traditionally for the management of various diseases in Africa. A decoction of the leaves and bark of *D. oliveri* is used for the treatment of gastrointestinal complaint, headaches, and as a mouthwash to treat toothache. *D. oliveri* has been reported to have, among other properties, antinociceptive,12–14 cytotoxic,15 hepatoprotective and antioxidant,16 anti-hyperglycemic,17 and anthelmintic activities.18,19 In addition, the antioxidant activity of the seed oil,21 oleoresin20 and leaves, stem bark and root bark22 have been reported.

Citation: Olaleye OO, Sofidiya MO, Ogba JO, Lasore W. Antioxidant activities of *Daniellia oliveri* (Rolfe) Hutch. & Dalziel and *Daniellia ogea* (Harms) Rolfe ex Holland (Caesalpiniaceae). Trop J Nat Prod Res. 2020; 4(5):210-215, doi:10.26538/tjnpr/v4i5.5

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria.
Ethnobotanically, the stem bark of *D. ogea* is taken in Senegal as an aphrodisiac. A decoction of the root is taken as a treatment of gonorrhea and malaria in Nigeria and Ghana. The gum is used in Nigeria as a purgative agent and for the treatment of snakebite. The plant is also used in Ghana for the treatment of cough and asthma. There are few reports on the pharmacological activity of *D. ogea*. A recent report demonstrated the antimarial and modulatory potentials of the plant. A study on the chemical constituents revealed the major component in the leaf oil includes caryophyllene oxide (20.1%), humulene oxide (6.9%), ß-humulene (3.8%) and ß-selinene (3.8%). In this study, a comparative antioxidant activity of the leaves and bark extracts of *Daniella oliveri* and *Daniella ogea* was investigated. The total polyphenolic contents in the extracts were also determined.

**Materials and Methods**

**Collection of plant materials**

Fresh leaves and stem bark of *D. oliveri* were collected in July 2010 along Lagos-Ibadan expressway at kilometer 42 while *D. ogea* was collected at Odofin Agbegi, Ikire, Osun State, Nigeria. The plants were identified by Mr. T.K. Odewo of the Herbarium Unit of Botany Department, University of Lagos, Lagos, Nigeria and assigned voucher numbers (*D. oliveri* - LUH 2784 and *D. ogea* - LUH 2783). The samples were then deposited at the Herbarium Unit, Department of Botany, University of Lagos, Nigeria.

**Extraction of plant materials**

Fresh samples of the leaves and stem bark of *D. oliveri* and *D. ogea* were air dried at room temperature until complete dryness was achieved. The dried samples were then ground to powder using a mechanical grinder (Christy and Norris, Chelmsford-England, 6000 rev per min, 810 LAB MILL, 50158). The powdered samples (400 g of each) were macerated in 1.5 L of absolute ethanol for 24 hours. The extracts were filtered using muslin cloth and the process was repeated for complete extraction. Each of the combined extracts was filtered and concentrated to dryness using rotary evaporator. The yield of the resultant extracts was calculated and extracts stored at 4°C until use.

**Phytochemical analysis**

The extracts of *D. oliveri* and *D. ogea* (leaves and stem bark) were analyzed for the presence of secondary metabolites using standard qualitative methods.

**Estimation of total phenolic content**

Total phenolic content was performed according to the protocol of Amazeeg et al. Gallic acid was prepared in methanol at five concentrations (0.01-0.05 mg/mL) and the plant extracts were also prepared in methanol at a concentration of 1 mg/mL. From each of the extract solutions, 0.5 mL was mixed with 2.5 mL of a 1 in 10 dilution of Folin-Ciocalteau’s reagent and 2 mL of 7.5% sodium carbonate. The mixture was left for 30 min at room temperature and the absorbance was read at 760 nm using a spectrophotometer. All determinations were performed in triplicates. The total phenolic contents were expressed as gallic acid equivalent (GAE) using the following equation based on calibration curve:

\[
y = 8.4944x + 0.0767, \quad R^2 = 0.9983,
\]

where *y* is the absorbance and *x* is the gallic acid equivalent (mg/g).

**Estimation of total flavonoid content**

Total flavonoid content was determined using the procedure of Sofidiya et al. Quercetin, prepared in methanol at five different concentrations of 0.01-0.05 mg/mL was used as a reference. Ethanol solution of 2% AlCl\(_3\) (1.5 mL) was added to 1.5 mL of each extract sample. The mixture was incubated for 1 h at room temperature after which the absorbance was measured at 420 nm. A yellow colour indicated the presence of flavonoids. Extract solutions were prepared in methanol and evaluated at a final concentration of 1 mg/mL. Total flavonoid contents were calculated as quercetin equivalent (mg/g) using the equation based on the calibration curve:

\[
y = 8.3558x + 0.2156, \quad R^2 = 0.9593,
\]

where *y* is the absorbance and *x* is the quercetin equivalent (mg/g).

**Estimation of total proanthocyanidin content**

Determination of proanthocyanidin content was based on the procedure reported by Asekunowo et al. Briefly, 0.5 mL of 1.0 mg/mL of extract solution was mixed with 1.5 mL of 4% vanillin-methanol solution and 0.75 mL concentrated hydrochloric acid. The mixture was left for 15 min at room temperature and the absorbance was measured at 500 nm. Total proanthocyanidin content was calculated with respect to catechin standard curve and results expressed as catechin equivalent (mg/g) following equation:

\[
y = 4.9944x + 0.0068, \quad R^2 = 0.9829,
\]

where *y* is the absorbance and *x* is the catechin equivalent (mg/g).

**In vitro antioxidant activity**

Each of the plant extracts (10 mg) was dissolved in 10 mL of 95% methanol to make a concentration of 1 mg/mL and then diluted to prepare the different concentrations for antioxidant assays. Tocopherol and quercetin were used as references in all the assays except where otherwise stated. All assays were performed in triplicates.

**Hydroxyl radical scavenging assay**

Hydroxyl radical scavenging activity of *D. oliveri* and *D. ogea* extracts were assayed by adopting the method described by Shah et al. with some modifications. A volume of 0.2 mL of extracts at concentration range of 10-100 µg/mL was added to a reaction mixture containing 0.2 mL of ferric chloride (0.1 M) and 0.2 mL of ethylenediaminetetraacetic acid, EDTA (0.1 M) (ratio 1:1), 0.2 mL of hydrogen peroxide (0.2 M, prepared in 20 mM of phosphate buffer pH 7.4) and 0.2 mL of 2-deoxyribose (3 mM, in 50 mM phosphate buffer, pH 7.4). Ascorbic acid (0.2 mL, 0.3 M) was then added to initiate a Fenton reaction. The reaction mixture was incubated for 1 h at 37°C. After incubation, 0.2 mL of trichloroacetic acid, TCA (2.8% w/v) and 0.2 mL of thiobarbituric acid, TBA (1% w/v) prepared in 50 mM NaOH was added and placed on a boiling water bath for 15 min. After cooling, the absorbance of the reaction mixture was measured at 532 nm and was converted into percentage inhibition of deoxyribose degradation according to the equation:

\[
\text{Scavenging activity} (\%) = \frac{[1 - \text{Sample absorbance}]}{\text{Control absorbance}} \times 100
\]

**Reducing power**

The reducing power capability of each plant extract was determined according to reported procedure by Jing et al. In brief, 1.5 mL of *D. oliveri* and *D. ogea* leaves and stem bark extract solutions (10 to 100 mg/mL) were mixed with 1.5 mL of sodium phosphate buffer (0.2 M, pH 6.6) and 1.5 mL of potassium ferricyanide (1%, w/v). The mixture was incubated for 20 min at 50°C and the mixture was cooled immediately. After incubation, 1.5 mL of trichloroacetic acid (10%, w/v) was added. After centrifugation at 3000 rpm for 10 min, 1.5 mL of the supernatant was vigorously mixed with 1.5 mL of deionized water and 0.3 mL of ferric chloride (0.1%, w/v). After a 10 min reaction time, the absorbance of the mixture was determined at a wavelength of 700 nm against distilled water. The higher the absorbance, the stronger the reducing power of the sample.

**Metal chelating activity assay**

The chelating activity of the extracts was measured following a previous study reported by Sofidiya and Familoni. In this method, ferrozine reacts with Fe\(^{2+}\) ions to form a purple complex that strongly absorbs at a wavelength of 562 nm, the intensity of which decreases in the presence of Fe\(^{2+}\) chelating agents. Concisely, an aliquot of 1.6 mL of deionized water and 0.05 mL of FeCl\(_3\) (2 mM) was added to 0.5 mL of each of the extracts. Thereafter, 0.1 mL of ferrozine (5 mM, dissolved in methanol) was added after 30 s to initiate the reaction. The mixture was then shaken thoroughly and left for 10 min at room temperature. The absorbance of the Fe\(^{2+}\) ferrozine complex formed was measured at 562 nm. Ethylenediaminetetraacetic acid (EDTA) was used as a positive control. The chelating activity of the extract for Fe\(^{2+}\) was calculated as;
chelating rate (%) = (A₀ - A₁)/ A₀ x 100
where A₀ was the absorbance of the control (blank, without extract) and A₁ was the absorbance in the presence of the extract.

**Determination of Fe²⁺-ascorbate-induced lipid peroxidation**

Inhibition of lipid peroxidation was estimated as illustrated by Ananthi et al.48 with slight modifications. This assay is based on the reaction of the product of lipid peroxidation malondialdehyde (MDA) with thiobarbituric acid reactive species (TBARS), which strongly absorbs at a wavelength of 532 nm. For this assay, liver homogenate which was prepared in Tris-HCl buffer, pH 7.4, with 10% w/v rat liver and centrifuged for 15 min at 3000 rpm producing a colourless supernatant served as the lipid-rich media. Each extract sample (0.5 mL) at varying concentration (10-100 µg/mL) was mixed with 1 mL of liver homogenate. Peroxidation was induced upon the addition of 0.05 mL of FeSO₄ (0.03 M), 0.1 mL of ascorbic acid (0.1 M) and 0.1 mL of KH₂PO₄ (0.01 M). The volume of the mixture was raised by adding distilled water up to 3 mL and was incubated at 37°C for 1 h. Thereafter, to each sample tubes, 1 mL each of trichloroacetic acid (5% w/v) and thiobarbituric acid (0.8% w/v) was added. The mixture was then centrifuged at 3500 rpm for 10 min and absorbance of the supernatant was measured at 532 nm. The percentage inhibition of lipid peroxidation was calculated using the equation;

% inhibition of lipid peroxidation = (Acontrol - Aextract/Acontrol) x 100

Where Acontrol is the absorbance of the control reaction and Aextract is the absorbance in the presence of the sample extracts.

**Statistical analysis**

All results are expressed as mean ± SEM and differences between means were statistically analyzed using one-way analysis of variance (ANOVA) followed by Tukey’s multiple range post-hoc test. Differences were considered significant at p < 0.05. The IC₅₀ values were calculated using AAT Bioquest® – EC50 calculator.

**Results and Discussion**

Phenolic compounds have been recognised to possess a wide range of biological activities, including antioxidant activity. In this study, the total polyphenolic contents and antioxidant activity of the ethanol extracts from the leaves and stem bark of *D. oliveri* and *D. ogea* were evaluated. Four different in-vitro antioxidant assays were employed, including hydroxyl radical scavenging, reducing power, metal chelating and lipid peroxidation assays.

The abilities of the extracts to inhibit hydroxyl radical-mediated deoxyribose degradation in a FeCl₂-EDTA-ascorbic acid and H₂O₂ reaction mixture is presented in Figure 1. All the extracts, tocopherol, and quercetin significantly (p < 0.05) inhibited hydroxyl radical in a concentration dependent manner. The scavenging ability of *D. oliveri* stem bark reached 40.84% at the lowest concentration of 10 µg/mL. The order of activity is; *D. oliveri* stem bark > *D. ogea* stem bark > *D. oliveri* leaf > *D. ogea* leaf. The hydroxyl radical attacks deoxyribose, which subsequently results in thiobarbituric acid reacting substance (TBARS) formation.39 This extremely reactive free radical formed in biological system has been implicated as a major active oxygen centered radical formed from the reaction of various hydroperoxides with transition metal ions, which is capable of damaging almost every molecule found in living system causing lipid peroxidation and biological damage.40 The results suggest the quenching ability of hydroxyl radicals and significant scavenger of active oxygen species of the extracts thus reducing the rate of chain reaction.

The reducing power assay is often used to determine the ability of an antioxidant to donate an electron or hydrogen. The reducing power of ethanol extracts of *D. oliveri* and *D. ogea* at different concentrations compared with that of tocopherol and quercetin as standards are presented in Figure 2. The increase in absorbance at 700 nm indicated better reducing power of the extracts. Among all the extracts, the highest reducing power activity was shown by *D. oliveri* stem bark followed by *D. ogea* stem bark, *D. ogea* leaf and *D. oliveri* leaf. The effect of the stem bark extract of *D. oliveri* (0.81) was higher than that of tocopherol (0.40) but less than quercetin (1.09). Studies revealed that there is a direct correlation between antioxidant activities and reducing power of certain bioactive compounds.41 The presence of antioxidants in the extracts resulted in reduction of the Fe²⁺/ferri cyanide complex to the ferrous form, Fe²⁺ estimated by measuring the formation of Perl’s Prussian blue at the wavelength of 700 nm. These results indicate that the extracts could donate an electron and neutralize free radicals and ROS.

The iron-chelating activity of the extracts of *D. oliveri* and *D. ogea* is presented in Figure 3. All the extracts showed lower activity in this assay. The iron chelating capacity of the extracts at the highest concentration of 100 µg/mL was significantly lower (p < 0.05) compared to EDTA. Studies have proven that metal chelation is an important antioxidant property owing to the iron binding ability of chelating agents in reducing metal-catalyzed oxidation leading to inhibition of reactive oxygen species generation.42 The formation of the ferrozine – Fe²⁺ complex was only interrupted by the extracts at the highest concentration, indicating chelating activity.

Lipid peroxidation causes damage to biological membranes, enzymes and proteins resulting in series of complications to human health.43 Changes in the absorbance of reaction mixture at the 532 nm resulting from inhibition of lipid peroxidation activities of *D. oliveri* and *D. ogea* extracts are presented in Figure 4. The extracts and the standards showed high inhibitory activity of lipid peroxidation. At 100 µg/mL, the percentage inhibition obtained for the stem bark and leaf of *D. ogea* was 67.75% and 68.46%, respectively. On the other hand, the % inhibitory effect of *D. oliveri* stem bark and *D. oliveri* leaf at this concentration was 71.30% and 67.14%, respectively. Judging from the IC₅₀ values (the concentration of an inhibitor that is required for 50% inhibition of its target -TBARS/lipid peroxidation), the inhibitory activity of the extracts is in the order *D. oliveri* leaf (3.71 µg/mL) > *D. ogea* stem bark (8.673 µg/mL) > *D. ogea* leaf (40 µg/mL) > *D. oliveri* stem bark (43 µg/mL). Several studies have reported iron inhibitory effect of lipid-thiobarbituric reactive species complex, indicating that the inhibition of lipid peroxidation by the samples could afford protection against oxidative damage.30,32,40 In general, our results corroborate the previous reports on substantial antioxidant activities of *D. oliveri* in 2,2-diphenyl-1-picrylhydrazyl (DPPH) and phosphomolybdenum assays.41

The antioxidant activity of plants may be due to the presence of phytochemicals like polyphenolics, sterols, and terpenes. In this study, the qualitative phytochemical screening of the extracts of *D. oliveri* and *D. ogea* revealed the presence of flavonoids, saponins, terpenoids and cardiac glycosides. In addition, alkaloids were detected in *D. ogea* stem bark and *D. ogea* leaf extracts. However, anthraquinones were not detected in any of the extracts (Table 1). This observation is at variance with previous preliminary phytochemical,r42 especially on *D. ogea*. The flavonoids present in the extracts, the leaves of *D. ogea* recorded the highest flavonoid content (99.82 ± 0.16 mg quercetin equivalent/g of dried extract). The content of proantocyanidins were 419.11 ± 0.16, 163.29 ± 0.03, 107.56 ± 0.04, 90.00 ± 0.02 mg catechin equivalent/g of dried extracts for *D. oliveri* stem bark, *D. ogea* stem bark, *D. oliveri* leaf and *D. ogea* leaf, respectively.

Phenolic compounds are very important plant constituents because of their scavenging ability on free radicals due to their hydroxyl groups.44 The hydroxyl donating groups in phenolics react with free radicals within the biological system resulting in antioxidant activities which may include radical scavenging, iron chelating, inhibition of lipid peroxidation and reducing power.45 Flavonoids are phenolic compounds with important roles in scavenging free radicals and they are valuable in preventing oxidative

© 2020 the authors. This work is licensed under the Creative Commons Attribution 4.0 International License
stress associated disorders. Proanthocyanidins have been reported to reduce intracellular reactive oxygen species thereby playing vital role as natural antioxidant. The presence of these phytochemicals may be accountable for the varying degree of antioxidant activity observed for the extracts. Furthermore, these results corroborate many reported studies revealing significant correlation between polyphenolic content and antioxidant capacity.

| Table 1: Yield (%) and phytochemical analysis of ethanol extract of D. ogea and D. oliveri |
| Extract | Yield (w/w %) | Alkaloids | Anthraquinones | Flavonoids | Saponins | Terpenoids | Cardiac glycosides |
|---------|---------------|-----------|----------------|------------|-----------|------------|------------------|
| Dog B   | 30%           | +         | -              | +          | +         | +          | +                |
| Dog L   | 7.5%          | -         | -              | +          | +         | +          | +                |
| Dol B   | 5%            | -         | -              | +          | +         | +          | +                |
| Dol L   | 10%           | +         | -              | +          | +         | +          | +                |

Dog B - D. ogea stem bark, Dog L - D. ogea leaves, Dol B - D. oliveri stem bark, Dol L - D. oliveri leaves. + Detected; - Not detected

| Table 2: Polyphenolic content of D. ogea and D. oliveri extracts |
| Plant Extract | Total phenolics (mg gallic acid equivalent/g dry extract) | Total flavonoids (mg quercetin equivalent/g dry extract) | proanthocyanidins (mg catechin equivalent/g dry extract) |
|---------------|----------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|
| Dog B         | 285.26 ± 0.04<sup>a</sup><sup>b</sup><sup>d</sup>          | 16.72 ± 0.02<sup>a</sup><sup>b</sup><sup>d</sup>          | 163.29 ± 0.03<sup>a</sup><sup>b</sup><sup>d</sup>          |
| Dog L         | 85.94 ± 0.06<sup>a</sup><sup>b</sup><sup>c</sup>           | 99.82 ± 0.16<sup>a</sup><sup>b</sup><sup>c</sup>           | 90.01 ± 0.02<sup>a</sup><sup>b</sup><sup>c</sup>           |
| Dol B         | 396.71 ± 0.01<sup>a</sup><sup>b</sup><sup>c</sup><sup>d</sup>   | 16.64 ± 0.01<sup>a</sup><sup>b</sup><sup>c</sup><sup>d</sup>   | 419.11 ± 0.16<sup>a</sup><sup>b</sup><sup>c</sup><sup>d</sup>   |
| Dol L         | 123.46 ± 0.06<sup>a</sup><sup>b</sup><sup>c</sup><sup>d</sup>   | 70.82 ± 0.04<sup>a</sup><sup>b</sup><sup>c</sup>           | 107.56 ± 0.04<sup>a</sup><sup>b</sup><sup>c</sup>           |

Data are expressed as mean ± SEM, n = 3. Dog B - D. ogea stem bark, Dog L - D. ogea leaves, Dol B - D. oliveri stem bark, Dol L - D. oliveri leaves. Means with superscripts with different letters in the columns are significantly (p < 0.05) different from each other where <sup>a</sup>p < 0.05 - versus Dol B, <sup>b</sup>p < 0.05 - versus Dol L, <sup>c</sup>p < 0.05 - versus Dog B and <sup>d</sup>p < 0.05 - versus Dog L.

Figure 1: Hydroxyl radical scavenging of D. oliveri and D. ogea extracts. Data are expressed as mean ± SEM, n = 3. Dog B - D. oliveri stem bark, Dog L - D. oliveri leaves, Dog B - D. ogea stem bark, Dog L - D. ogea leaves.

Figure 2: Reducing power of D. ogea and D. oliveri extracts. Data are expressed as mean ± SEM, n = 3. Dog B - D. ogea stem bark, Dog L - D. ogea leaves, Dog B - D. oliveri stem bark, Dog L - D. oliveri leaves.
Conflict of interest

The authors declare no conflict of interest.

Authors’ Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

References

1. Shang HM, Zhou HZ, Yang JY, Li R, Song H, Wu HX. In vitro and in vivo antioxidant activities of inulin. PLoS One 2018; 13(2):e0192273.

2. Mahdi-Pour B, Jothiy SL, Latha LY, Chen Y, Sasidharan S. Antioxidant activity of methanol extracts of different parts of Lantana camara. Asian Pac. J Trop Biomed. 2012; 2(12):960–965.

3. Onoja SO, Onem YN, Ezeeja MI, Chukwu MN. Evaluation of the in vitro and in vivo antioxidant potentials of Aframomum melegueta methanolic seed extract. J Trop Med. 2014;2014:1–6.

4. Lawal B, Shittu OK, Obiokpa FI, Berinyuy EB, Mohammed H. African natural products with potential antioxidants and hepatoprotective properties: a review. Clin Phytosci 2016; 2(23):1.

5. Sila A, Haddar A, Martinez-Alvarez O, Bougatef A. Angiotensin-I-Converting Enzyme Inhibitory and Antioxidant Activities of Protein Hydrolysate from Muscle of Barbel (Barbus callensis). J Chem. 2013:2013:1–6.

6. Farvín SKH and Jacobsen C. Antioxidant activity of seaweed extracts: in vitro assays, evaluation in 5 % fish oil-in-water emulsions and characterization. J Am Oil Chem Soc. 2015;92(4):571–587.

7. Altemimi A, Lakhasssi N, Baharlouei A, Watson D, Lightfoot D. Phytochemicals: extraction, isolation, and identification of bioactive compounds from plant extracts. Plants 2017; 6:42.

8. Krishniah D, Sarbatly R, Bono A. Phytochemical antioxidants for health and medicine a move towards nature. Biotechnol Mol Biol Rev. 2007; 2(4):97–104.

9. Shehab NG, Abu-Gharbieh E, Bayouni FA. Impact of phenolic composition on hepatoprotective and antioxidant effects of four desert medicinal plants. BMC Compl Altern Med. 2015; 15(1):1.

10. Burkhill HM. The useful plants of West Tropical Africa. (2nd ed., Vol. 3). United Kingdom: Royal Botanic Gardens, Kew, Richmond; 1985. 857 p.

11. Danlami U and David BM. Physicochemical properties and antioxidant potentials of Daniellia oliveri seed oil. Res J Eng Appl Sci. 2012; 1:389-392.

12. Onwuakee ND. Pharmacological activities of extracts of Daniellia oliveri (Rolfe) Hutch. and Dalz. (Leguminosae). Phytother. Res. 1995; 9(4):306–308.

13. Jegede IA, Nwinyi FC, Muazzam I, Akumka DD, Njan AA, Shok M. Micromorphological, anti-nociceptive and anti-inflammatory investigations of stem bark of Daniellia oliveri. Afr J Biotechnol. 2006; 5(10):903-935.

14. Boye A, Amoateng P, Koffuor GA, Barku VYA, Bawu EM, Anto OE. Anti-nociceptive and antioxidant activity of an aqueous root bark extract of Daniellia oliveri (Rolfe) Hutch. & Dalziel (Fam: Leguminosae {Fabaceae}) in ICR mice. J Appl Pharm Sci. 2013; 3(12):36–45.

15. Fadeyi SA, Fadeyi OO, Adejumo AA, Okoro C, Myles EL. In vitro anticancer screening of 24 locally used Nigerian medicinal plants. BMC Compl Altern Med. 2013; 13(1):79–88.

16. Onoja SO, Madubuike GK, Ezeja MI. Hepatoprotective and antioxidant activity of hydromethanolic extract of Daniellia comphol

100 -30
-40
-50
-60
-70
-80
-90
-100
EDTA Dol B Dog L Dol B Dog L Dol B Dog L

Figure 3: Fe$^{2+}$ chelating effect of D. ogea and D. oliveri extracts in comparison with EDTA. Data are expressed as mean ± SEM, n = 3. Dog B - D. ogea stem bark, Dog L - D. ogea leaves, Dol B - D. oliveri stem bark, Dol L - D. oliveri leaf.

120
110
100
90
80
70
60
50
40
30
20
10
0
Dol B Dog L Dog B Dol L Quercetin Tocopherol

Figure 4: Inhibition of lipid peroxidation by D. ogea and D. oliveri extracts. Data are expressed as mean ± SEM, n = 3. Dog B - D. ogea stem bark, Dog L - D. ogea leaf, Dol B - D. oliveri stem bark, Dol L - D. oliveri leaf.

Conclusion

The study demonstrated significant variations in the antioxidant activities of the leaves and stem bark of D. oliveri and D. ogea. The stem bark extracts of the two plants were found to have better in vitro antioxidant activities as demonstrated in this study. They also possessed significant total phenolic and proanthocyanidin contents. The isolation and characterization of bioactive compounds from these plants as natural antioxidants could provide valuable therapeutic agents for oxidative-stress induced disorders.
oliveri leaves in carbon tetrachloride-induced hepatotoxicity in rats. J Basic Clin Physiol Pharmacol. 2015; 26(5):465-470.

17. Iwuweke AV and Nwodo OFC. Anti-hyperglycemic effect of aqueous extract of Daniella oliveri and Sarcoccephalus latifolius roots on key carbohydrate metabolic enzymes and glycogen in experimental diabetes. Biochemistri. 2008; 20(2):63-70.

18. Adama K, Adama B, Tamboura H, Amadou T, Laye S. In vitro anthelmintic effect of two medicinal plants (Anogeissus leiocarpus and Daniella oliveri) on Haemonchus contortus, an abomasal nematode of sheep in Burkina Faso. Afr J Biotechnol. 2009; 8(18):4690-4695.

19. Kabore A, Traore A, Tamboura HH, Belem AMG. Anthelmintic activity of Daniella oliveri against Haemonchus contortus worms in Burkina Faso. Int At Energy Agency Bull. 2009; 41(4):8-11.

20. Atolani O and Olatunji GA. Isolation and evaluation of antilipoglycemic potential of polyalcoholic (furano-terpene) from Daniella oliveri. J Pharm Anal. 2014; 4(6):407-411.

21. Luanda F, Koó D, Dicko A, Souliman R, Younos C. Phytochemical Composition and Antioxidant Capacity of Three Malian Medicinal Plant Parts. Evid Based Compl Altern Med. 2011; 1:8–10.

22. Ezenyi IC, Verma V, Singh S, Okhale SE, Adzu B. Ethnopharmacology-aided antiplasmodial evaluation of six selected plants used for malaria treatment in Nigeria. J Ethnopharmacol. 2020; 254:x.

23. Ezuruake UF, Chici E, Pietro JM. In vitro modulation of glabemclamide transport by P-glycoprotein inhibitor antidieabetic African plant extracts. Planta Med. 2019; 85(11/12):987-996.

24. Asekun OT and Ekundayo O. The Leaf Oil of Daniella aega L. J Essent Oil Res. 2004; 16(4):282-283.

25. Sofowora H. Screening Plants for bioactive agents. In medicinal plants and traditional medicine in Africa. (2nd ed.) Sunshine House, Ibadan, Nigeria: Spectrum Books Ltd; 1993. 134-156 p.

26. Trease GE and Evans WC. A textbook of Pharmacognosy. (13th edition). London: Bailliere Tindall; 1989. 345-365 p.

27. Amaeze OU, Ayoola GA, Sofidiya MO, Adepou-Bello AA, Adegoke AO, Coker HAB. Evaluation of antioxidant activity of Tetrapyrindium conophorum (Mull. Arg.) Hutch & Dalziel Leaves. Oxid Med Cell Longev. 2011;2011:1-7.

28. Sofidiya MO, Jimoh FO, Alero AA, Afolayan AJ, Odukoya OA, Familoni OB. Antioxidant and antibacterial properties of Lecaniodiscus cupanioides. Res J Microbiol. 2008; 2:91-98.

29. Asekunowo AK, Ashafa AOT, Okoh O, Asekun OT Familoni OB. Polyphenolic constituents, antioxidant and hypoglycaemic potential of leaf extracts of Acalypha godseffiana from Eastern Nigeria: In vitro study. J Med Plants Eco Dev. 2019; 3(1):a36.

30. Shah NA, Khan MR, Ahmad B, Nooreen F, Rashid U, Khan RA. Investigation on flavonoid composition and anti free radical potential of Sida cordata. BMC Compl Altern Med. 2013; 13:376.

31. Jing YS, Zhu JH, Liu T, Bi SX, Hu XJ, Chen ZY, et al. Structural characterization and biological activities of a novel polysaccharide from cultured Cordyceps smithii and its sulfated derivative. J Agric Food Chem. 2015; 63:3464–3471.

32. Sofidiya MO and Familoni OB. Antioxidant activities of different solvent extracts of leaves and root of Flabelaria paniculata Cav. (Malpighiaceae). J Med Plant Res. 2012; 6(31):4682-4690.

33. Ananthi S, Raghavendran HRB, Sunil AG, Gayathri V, Ramakrishnan G, Vasanthi Hannah R. In vitro antioxidant and in vivo anti-inflammatory potential of crude polysaccharide from Turbinaria ornata (Marine Brown Alga). Food Chem Toxicol. 2010; 48:187–192.

34. AAT Bioquest, Inc. Quest GraphTM IC50 Calculator. [Online]. [Cited 2020, May 13]. Available from: https://www.aatbio.com/tools/ic50-calculator.

35. Ashokkumar D, Thamilselvan V, Senthilkumar GP, Mazumder UK, Gupta M. Antioxidant and free radical scavenging effects of Lippia nodiflora. Pharm Biol. 2008; 46(10-11):762–770.

36. Pedraza-Chaverri J, Medina-Campos ON, Ávila-Lambordo R, Berenice Zúñiga-Bustos A, Orozco-Ibarra M. Reactive oxygen species scavenging capacity of different cooked garlic preparations. Life Sci. 2006; 78(7):761–770.

37. Synowiecki J and Al-Khateeb NAAQ. The recovery of protein hydrolysate during enzymatic isolation of chitin from shrimp. Crangel M, Hannah processing discards. Food Chem. 2000; 68(2):147-152.

38. Gülker Ï, Elmasat M, Aboul-Enein HY. Antioxidant activity of clove oil – A powerful antioxidant source. Arab J Chem. 2012; 5(4):489–499.

39. He R, Ju X, Yuan J, Wang L, Girgih AT, Aluko RE. Antioxidant activity of rape seed peptides produced by solid state fermentation. Asia Pac J Food Res. 2012; 276:199–211.

40. Noureen F, Khan MR, Shah NA, Khan RA, Naz K, Sattar S. Pasticia chinensis; Strong antioxidant and potent testicular toxicity amelioration agent. Asian Pac J Trop Med. 2017; 10(4):380–389.

41. Alain KY, Valentin WD, Christian KT, Pascal AD, Dominique SC. Phytochemical screening, antibacterial and anti-radical activities of Daniella oliveri trunk bark extracts used in veterinary medicine against gastrointestinal diseases in Benin. Int J Res. 2015; 3(10):1190-1198.

42. Akharaiyi FC and Boboye B. Antibacterial and phytochemical evaluation of three medicinal plants. J Nat Prod. 2010; 3:27-34.

43. Coker ME and Ogundele OS. Evaluation of The Anti-Fungal Properties of Extracts of Daniella oliveri. Afr J Biomed Res. 2016; 19(1):55-60.

44. Ahmed AF, Atta FAK, Liu Z, Li C, Wei J, Kang W. Antioxidant activity and total phenolic content of essential oils and extracts of sweet basil (Ocimum basilicum L.) plants. Food Sci Human Well. 2019; 8(3):299-305.

45. Sørensen AM, Nielsen NS, Yang Z, Xu X, Jacobsen C. Synowiecki J and Edelberg S. Polyphenol profiling and antioxidant activity of rape seed peptides produced by solid state fermentation. BioTechnol. 2013; 2(1):283-288.

46. Asekunowo AK, Ashafa AOT, Okoh O, Asekun OT Familoni OB. Polyphenolic constituents, antioxidant and hypoglycaemic potential of leaf extracts of Acalypha godseffiana from Eastern Nigeria: In vitro study. J Med Plants Eco Dev. 2019; 3(1):a36.

20. Shah NA, Khan MR, Ahmad B, Nooreen F, Rashid U, Khan RA. Investigation on flavonoid composition and anti free radical potential of Sida cordata. BMC Compl Altern Med. 2013; 13:376.

3. Jing YS, Zhu JH, Liu T, Bi SX, Hu XJ, Chen ZY, et al. Structural characterization and biological activities of a novel polysaccharide from cultured Cordyceps smithii and its sulfated derivative. J Agric Food Chem. 2015; 63:3464–3471.

4. Sofidiya MO and Familoni OB. Antioxidant activities of different solvent extracts of leaves and root of Flabelaria paniculata Cav. (Malpighiaceae). J Med Plant Res. 2012; 6(31):4682-4690.

5. Ananthi S, Raghavendran HRB, Sunil AG, Gayathri V, Ramakrishnan G, Vasanthi Hannah R. In vitro antioxidant and in vivo anti-inflammatory potential of crude polysaccharide from Turbinaria ornata (Marine Brown Alga). Food Chem Toxicol. 2010; 48:187–192.

215 © 2020 the authors. This work is licensed under the Creative Commons Attribution 4.0 International License.