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Antioxidant potential of extracts from *Allophylus decipiens* - A medicinal plant from the Kingdom of Eswatini

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ABSTRACT

Allophylus decipiens belongs to the Sapindaceae family of the genus Allophylus. The species belong to the Allophylus genus have widely been used in the traditional medicine to treat various conditions which include fever, cough, wound, diarrhoea, dysentery, pulmonary troubles, pain, and heart diseases. The present study aimed to evaluate the antioxidant potential and to determine the IC_{50} value, total phenolic contents (TPCs) and total flavonoid contents (TFCs) of various solvent extracts obtained from the leaves and stem-bark of *A. decipiens*. Maceration technique was used first followed by hot solvent extraction technique to obtain various solvent extracts. DPPH radical scavenging assay was employed to evaluate the antioxidant potential and to determine the IC_{50} values. Folin-Ciocalteu and aluminium chloride colorimetric methods were employed to determine the TPCs and TFCs, respectively. The percentage of DPPH radical scavenged by various extracts obtained from the leaves and stem-bark and the positive control (ascorbic acid) was found to be in the ranges of 10.85±0.79-77.69±1.01%, 2.67±0.83-71.4±0.36[d]% and 53.67±0.58-84.23±0.66%, respectively at a concentration range of 200-3000µg/mL. Additionally, the IC_{50} values of these extracts were determined to be in the ranges of 857.37->3000 and 1336.52->3000µg/mL, respectively and the IC_{50} value of the positive control was determined as <200 µg/mL. The methanol extracts obtained from the leaves and stem-bark showed lowest IC_{50} values of 857.37 and 1336.52µg/mL, respectively. Furthermore, the TPCs of various extracts obtained from the leaves and stem-bark were determined to be in the ranges of 0.82±0.07-15.81±1.96 and 1.13±0.19-72.62±7.91mg of gallic acid equivalent per gram dry weight of the extract (mg GAE/g DW), respectively. The TFCs of various extracts obtained from the leaves and stem-bark were determined in the ranges of 13.49±1.44-18.57±4.60 and 15.71±1.08-49.05±4.54 mg of quercetin equivalent per gram dry weight of the extract (mg QE/g DW), respectively. From this study, we concluded that various extracts obtained from the leaves and stem-bark of *A. decipiens* showed a moderate to significant DPPH radical scavenging potential. In addition, these extracts possessed a moderate to higher TPCs and TFCs.Various other bioassays, isolation and characterization of pure compounds on various parts of this plant and bioassays on the isolated pure compounds are recommended as future perspectives on this plant.

Keywords: *Allophylus decipiens*, Sapindaceae, antioxidant activity, DPPH radical scavenging assay, IC_{50} values, total phenolic contents (TPCs), total flavonoid contents (TFCs).

1. INTRODUCTION

Allophylus decipiens belongs to the Sapindaceae family of the genus Allophylus (Leenhouts, 1967). Approximately, 1900 species are available in the Sapindaceae family (Harrington and Gadek, 2010; Ejike et al., 2023) and approximately, 255 species are available in this Allophylus genus (Leenhouts, 1967). Members of the Sapindaceae family are mainly distributed in temperate and tropical climates (Harrington and Gadek, 2010). *A. decipiens* is distributed in the southern part of the African continent which include Eswatini (Swaziland), Mozambique and South Africa (Goldblatt et al., 2000; Victor and van Wyk, 2005; Raimondo et al., 2009; Boon, 2010). In South Africa, *A. decipiens* is available in Eastern Cape, KwaZulu-Natal, Mpumalanga and, Western Cape Provinces. (Goldblatt et al., 2000; Victor and van Wyk, 2005; Raimondo et al., 2009; Boon, 2010). *A. decipiens* has several vernacular names which include Bastard currant, Bastard taaibos, False currant, Small leaved false currant, Rooibessieboom, Valstaaibos, Umcandathambo, Umhlohlela, Umncandathambo and Uthathabani (Goldblatt et al., 2000; Victor and van Wyk, 2005; Raimondo et al., 2009; Boon, 2010). *A. decipiens* is a shrub or small tree and, it grows up to 4 meters in height. *A. decipiens* has trifoliolate leaves and pale grey bark. *A. decipiens* blooms fragrant flowers during autumn and these flowers appear whitish small clusters. *A. decipiens* yields spherical or near-spherical shaped fruits (berries) of approximately 6 mm in diameter and these fruits are changed to bright red on maturation (Exell and Fernandes, 1966; Govaerts, 1995; Goldblatt et al., 2000; Germishuizen and Meyer, 2003; Victor and van Wyk, 2005; Raimondo et al., 2009; Boon, 2010). The species belong to Allophylus genus have widely been used in the traditional medicine to treat various conditions which include fever, cough, wound, diarrhoea, dysentery, pulmonary troubles, pain, and heart diseases (Burkill, 2000; Freisesleben et al., 2017; Sara et al., 2017; Abiodun et al., 2021; Ejike et al., 2023; Ejike wt al., 2025). Additionally, various classes of compounds have been reported from the species belong to this Allophylus genus which include tannins, saponin, anthocyanin , betacyanin, flavonoids, alkaloids, terpenoids, phenol, coumarins, steroids, anthraquinones, carbohydrates, and fatty acids (Kumar et al., 2010; Ali et al., 2011; Zhang et al., 2012; Oladosu et al., 2013; Oladosu et al., 2015; Abiodun et al., 2021; Andrea et al., 2021; Jemal et al., 2022; Ejike et al., 2023; Nkeoma et al., 2024; Diogenes et al., 2015).

Our literature search revealed that *A. decipiens* has not been investigated for biological, pharmacological and phytochemical studies. Particularly, *A. decipiens* species from the Kingdom of Eswatini remained unexplored. Therefore, in the present study, we aimed to evaluate the antioxidant activity of *A. decipiens* with particular objectives to evaluate the DPPH radical scavenging potential and to determine the IC_{50} values, the total phenolic contents (TPCs) and the total flavonoid contents (TPCs) of pentane, dichloromethane, ethyl acetate, acetone, and methanol crude extracts obtained separately from the leaves and stem-bark of *A. decipiens* collected in the Kingdom of Eswatini. The results are summarized in this article. To the best of our knowledge, this is the first report of this kind particularly, *A. decipiens* collected from the Kingdom of Eswatini.

2. MATERIALS AND METHODS

Collection of plant materials

Fresh leaves and stem-bark of *A. decipiens* were collected in September 2024 along the Lusutfu River at Bhunya, MT of Manzini region in the Kingdom of Eswatini. The plant materials were identified by Dr. M. N. Dludlu, Department of Biological Sciences, University of Eswatini (UNESWA) and specimen for leaves (ADLS2024) and stem-bark (ADSS2024) were kept separately at the Laboratory for Chemistry Research Project (LCRP).

Processing of plant material

The plant materials were air-dried at LCRP for four weeks. A laboratory grinder (MRC Laboratory Equipment, Model KM 1500) was used to ground these air-dried plant materials into fine power. Masses of 739.830 and 736.900g of powdered leaves and stem-bark respectively were obtained.

Preparation of plant extracts

Table 1 given below summarizes the plant parts of *A. decipiens* used for extraction, masses of plant materials used, and solvents used for each extraction and the amount of crude extracts obtained from each solvent. The solvents were chosen based on their increasing polarity to extract a broad spectrum of phytochemicals.

Table 1: Plant parts, solvents and amount of plant materials used for extraction and amount of crude extracts obtained from each solvent.

S. No.	Plant parts used	Solvents used	Amount of plant materials used (g)	Amount of crude extracts obtained (g)
1	Leaves	Hexane	80.252	0.980
2	Leaves	Dichloromethane	80.451	1.307
3	Leaves	Ethyl acetate	80.339	2.280
4	Leaves	Acetone	80.204	1.766
5	Leaves	Methanol	80.821	2.039
6	Stem-bark	Hexane	80.824	0.668
7	Stem-bark	Dichloromethane	80.532	0.978
8	Stem-bark	Ethyl acetate	80.268	1.890
9	Stem-bark	Acetone	80.102	1.124
10	Stem-bark	Methanol	80.574	2.092

The above weighed powdered leaves (refer Table 1) was macerated separately at room temperature at 27-29°C for 24 hours with occasional shaking. After maceration, the solvent decanted, filtered, and distilled. A crude extract was obtained from each one of the above solvents and kept separately in a previously weighed china-dish. The powdered leaves recovered from each one of the above maceration processes and then extracted again separately with the same solvent for 8 hours but under reflux conditions. The solvent decanted, filtered, and distilled as previously. The crude extract obtained in this hot solvent extraction technique was combined with crude extract obtained previously from the maceration technique. The amounts of combined crude extracts obtained from each one of the solvents are listed in Table 1. Similarly, the same procedure was repeated for each one of the above weighed powdered stem-bark (refer Table 1) and the amounts of combined crude extracts obtained from each one of the solvents were also listed in Table 1.

Chemicals, solvents, and reagents

All chemicals, reagents, and solvents used in this study were of AR grades. Sodium carbonate, quercetin, tannic acid, and Folin-Ciocalteu reagent purchased from Associated Chemical Enterprises (ACE). Sodium phosphate received from Glass World. Sodium nitrite purchased from Rochelle Chemicals. Sodium hydroxide obtained from MCB Laboratory and Medical Suppliers. Ascorbic acid, tris- hydrochloric acid buffer, 2,2- diphenyl-1-picrylhydrazyl and solvents viz. pentane, dichloromethane, ethyl acetate, acetone and methanol were all procured from Promark chemicals.

Free radical scavenging activity of extracts

2,2-Diphenyl-1-picrylhydrazyl (DPPH) assay was employed to evaluate the antioxidant activity of various extracts obtained from the leaves and stem-bark of *A. decipiens*. Usually, free radicals are less stable but ironically, DPPH is a stable free radical and the purple-colored methanol solution of DPPH radicals reduce to yellow colored DPPH-H neutral molecules if DPPH radicals encounter hydrogen atoms from donor molecules present in the plant extract. DPPH assay was performed as per methods described in literature (Pillai et al., 2019; Mpopo et al., 2021; Pillai and Mthimkhulu, 2024; Pillai and Samkelisiwe, 2024; Pillai and Simelane, 2025). Stock solutions of each extract and positive control (ascorbic acid) were prepared separately by dissolving 3.0mg of extract or ascorbic acid in 1.0mL of 50% methanol (v/v). Various dilutions such as 3000, 2000, 1500, 1000, 800, 500 and 200µg/mL were also prepared separately from each one of the above stock solutions. A 50% methanol solution served as a negative control (v/v). A solution of 50mM phosphate buffered saline (PBS) served as a buffer (pH 7.4). The buffer is used to maintain a stable pH, to ensure that the DPPH radical is soluble in the reaction mixture and therefore, causes maximum absorbance (Sharma and Bhat, 2009; Maura et al., 2013; Sascha and Herbert, 2014). A volume of 100mL of 0.1mM DPPH solution was prepared by dissolving 3.94mg of DPPH in methanol, which served as an oxidant. A volume of 20µL of extract solution or positive control, 200µL of 0.1 mM DPPH solution and 90µL of 50mM PBS buffer at pH 7.40 served as a reaction mixture. The reaction mixture was incubated for 30 minutes in a dark cabinet. The absorbance of the reaction mixture was then measured at 517nm using a UV-Vis spectrometer (Infinite M200). The absorbance of the negative control i.e. the solution without the extract or positive control was also measured by the procedure as described previously. As such, the negative control exhibited maximum absorbance due to the presence of a large number of DPPH radicals. In the presence of the extract or positive control, the

DPPH radicals reduce to DPPH-H neutral molecules due to the availability of hydrogen donors from the extract or positive control. Therefore, in the presence of the extract or positive control, the absorbance values are lowered and it depends on the concentration of extract solutions or positive control. Lower values of absorbance indicate the higher the concentrations of extract solutions or positive control and *vice versa*. In other words, a lower value of absorbance indicates a higher free radical scavenging (antioxidant) activity of an extract or positive control and *vice versa*. In the present study, the experiments were conducted in triplicates and the average of three experimental values were used to calculate the percentage inhibition of radical scavenging ability of various extracts and positive control using the equation given below (Matamane et al., 2020; Mokoroane et al., 2020).

DPPH Radical Scavenged (%) = [(A of control – A of test)/A of control] × 100
A of test = Absorbance of extract solution or positive control.
A of control = Absorbance of negative control.

The half-minimal inhibition concentration (IC_{50}) values (i. e. the concentration in µg/mL of an extract or pure compound that inhibits the formation of DPPH radical by fifty percent) was determined from graphs by plotting extract concentrations (in x-axis) against the percentage inhibition of DPPH radical (in y-axis).

Determination of total phenolic contents (TPCs)

The Folin-Ciocalteu colorimetric method was employed to determine the total phenolic contents **(**TPCs) of various extracts obtained from leaves and stem-bark of *A. decipiens* as per details available in the literature (Selepe and Pillai, 2022; Pillai et al., 2023a; Pillai et al., 2023b). Gallic acid served as a standard to get a calibration curve. A stock solution of gallic acid was prepared by dissolving 1.0g of gallic acid and 1.0mL of 50% methanol *(v/v)*. Various dilutions such as 5, 10, 20, 40, 80, 100 and 200µg/mL were prepared from the stock solution. A 50% methanol (*v/v*) served as a negative control. Similarly, the test solution of each extract was prepared separately by dissolving 1.0mg of sample in 1.0mL of 50% methanol (*v/v*). The Folin- Ciocalteu reagent was dissolved in deionized water (1: 4, *v/v*) and was utilized. A volume of 50µL of test solution and 50µL of Folin-Ciocalteu reagent served as a reaction mixture. The reaction mixture was incubated for 5 minute and then 5.0mL of 7.5% sodium carbonate solution was added to this reaction mixture. The resulting reaction mixture was then incubated for 30 minutes at 40°C in a dark cabinet. The absorbance of the resulting mixture was measured at 760nm using a UV-Vis spectrometer (Infinite M200). The experiment was carried out in triplicates and the average of the three values was used for the calculation of the TPCs of each extract. Gallic acid served as standard. A calibration curve for the standard was obtained (y = 0.0007x + 0.0541; R^2 = 0.9829) by plotting various concentrations of the solutions *versus* their absorbance (Figure 1). This calibration curve was employed to estimate the TPCs of the various extracts and was expressed as milligrams of gallic acid equivalent per gram dry weight of the extract (mg GAE/g DW).

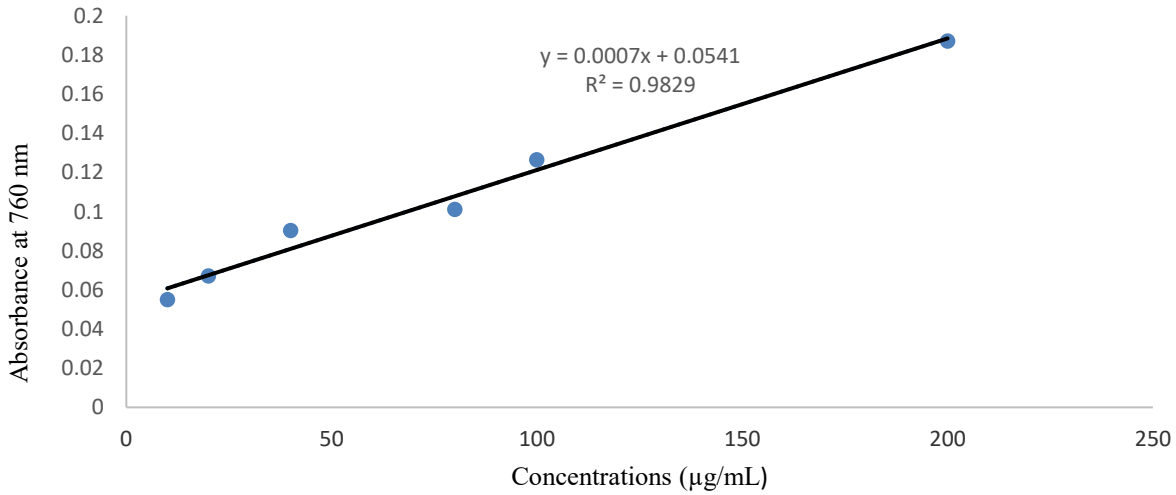

Figure 1: The calibration curve of gallic acid used to estimate of TPCs of various extracts.

The total flavonoid contents (TFCs) of various extracts obtained from the leaves and stem-bark *A. decipiens* was determined using aluminium chloride colorimetric method as per details given in the literature (Selepe and Pillai, 2022; Pillai et al., 2023a; Pillai et al., 2023b). Quercetin served as a standard to get a calibration curve. A mass of 1.0mg of quercetin was dissolved in 1.0mL of 50% of methanol which served as a stock solution and serial dilutions such as 10, 20, 40, 80, 100 and 200µg/mL were prepared from this stock solution. Similarly, stock solutions of each extract were prepared separately by dissolving 1.0mg of sample in 1.0mL of 50% methanol. A 50% methanol (*v*/*v*) blank solution served as a negative control. A volume of 150µL of extract sample and 150µL of sodium nitrite served as a reaction mixture. The reaction mixture was allowed to react for five minutes. After that 150µL of 10% aluminium chloride, 200µL of 1.0M sodium hydroxide and 600µL of deionized water were added to this reaction mixture. The resulting mixture was then incubated for 30 minutes in a dark cabinet at room temperature. The absorbance of each mixture was then measured against 50% methanol solution at 490nm using a UV-Vis spectrometer (Infinite M200). Each experiment conducted in triplicates and the average of the three values was used for the calculation of the TFCs of each extract. Similarly, the absorbance of the standard was measured by the procedure as described previously. A calibration curve for standard was obtained ($y = 0.0404x + 0.0200$; $R^2 = 0.9916$) by plotting the various concentrations of the solutions *versus* their absorbance (Figure 2). This calibration curve was employed to determine the TFCs of various extracts and was expressed in milligrams of quercetin equivalent per gram dry weight of the extract (mg QE/g DW).

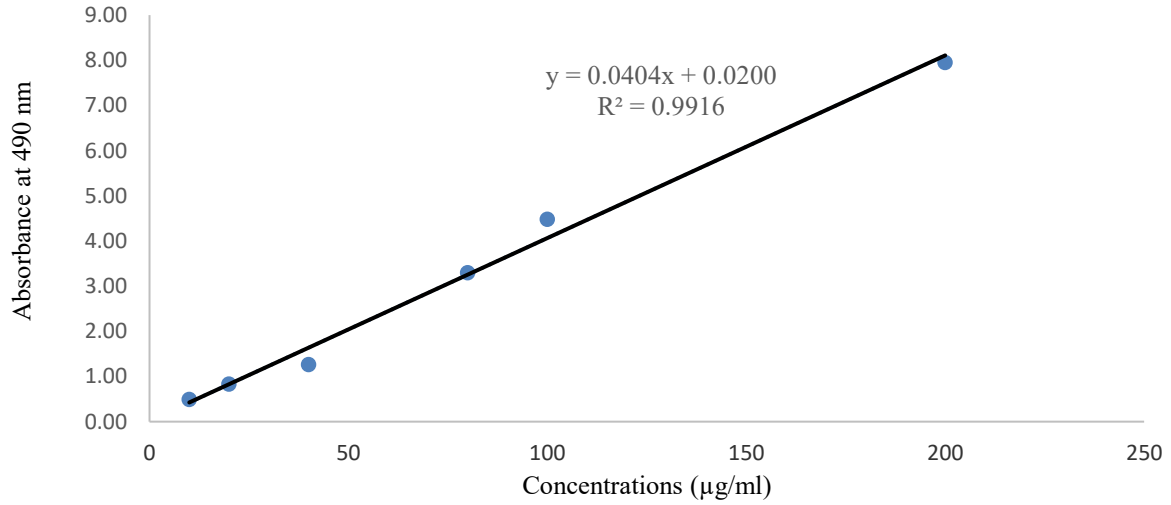

Figure 2: The calibration curve of quercetin used to estimate of TFCs of various extracts.

Statistical analysis

SPSS software version 28.0.0.0 was employed for statistical analysis. The difference between means was statistically significant when $p \leq 0.05$.

3. RESULTS AND DISCUSSION

Pentane, dichloromethane, ethyl acetate, acetone, and methanol crude extracts were obtained from leaves of *A. decipiens* and they were labeled as LS1, LS2, LS3, LS4, and LS5, respectively. Similarly, pentane, dichloromethane, ethyl acetate, acetone, and methanol crude extracts were obtained from stem-bark of *A. decipiens* and they were labeled as SB1, SB2, SB3, SB4, and SB5, respectively. The percentage of radical scavenging capacity of these ten extracts (LS1-LS5 and SB1-SB5) and positive control (ascorbic acid) was evaluated at concentrations of 200, 500, 800, 1000, 1500, 2000 and 3000µg/mL and the results are summarized in Table 2. The percentage of radical scavenging potential of these extracts showed a linear relationship with concentrations. In other words, increases in the concentrations of extracts caused increases in the percentage of radical scavenging potential. Extracts LS1-LS5 exhibited scavenging potential of 41.792±0.08, 46.23±1.08, 55.34±0.39, 69.65±0.67, and 77.69±1.01%, respectively, at 3000µg/mL (refer Table 2). The positive control showed a scavenging potential of 84.23±0.66% at 3000µg/mL (refer Table 2). This result indicated that LS1 and LS5 exhibited lowest and highest scavenging potential respectively, among the extracts obtained from the leaves at a concentration of 3000µg/mL. Extract LS1 was a pentane crude extract obtained from the leaves of *A. decipiens*. Pentane is a non-polar solvent and therefore, it has the ability to extract

non-polar fatty matters such as fatty acids and fatty esters. Additionally, due to its non-polar nature, pentane might have poor extraction power for polar compounds. Compounds that have ability to donate protons behave as antioxidants. Although, pentane has the ability to extracts fatty acids and the polar end of these fatty acids has the ability to donate protons, the available quantity of fatty acids in this particular pentane extract might have been limited. Therefore, LS1 showed relatively lower scavenging activity. On the other hand, LS5 was a methanol crude extract obtained from the leaves of *A. decipiens*. Methanol is a polar solvent and this polar solvent has the ability for extracting polar compounds which include alkaloids, steroids, terpenoids, tannins, phemolics, flavonoids and coumarins. In general, compounds such as phenolics and flavonoids can donate acidic hydrogen atoms readily from their hydroxyl groups. These acidic protons have the ability to scavenge free radicals (oxidants) effectively and therefore, phenolics and flavonoids compounds are served as powerful antioxidants. Analysis of results revealed that all five extracts (LS1-LS5) obtained from the leaves of *A. decipiens* showed relatively lower scavenging potential at all concentrations compared to positive control (refer Table 2). However, the methanolic extract (LS5) exhibited comparable activity as that of positive control at elevated concentrations (refer Table 2).

Table 2: DPPH radical scavenging potential of various extracts obtained from the leaves and stem-bark of *A. decipiens*.

Extracts	Concentrations (µg/mL) / Inhibition (%)							IC_{50} (µg/mL)
	200	500	800	1000	1500	2000	3000	
LS1	10.85±0.79^{a}	12.5±0.31^{a}	13.36±0.93^{a}	19.76±10.0^{a}	26.13±4.12^{a}	28.14±1.05^{a}	41.792±0.08^{a}	>3000
LS2	12.90±0.25^{a}	18.97±0.36^{a}	25.03±0.14^{a}	27.30±0.69^{a}	31.40±0.90^{a}	37.63±1.38^{a}	46.23±1.08^{a}	>3000
LS3	17.70±1.03^{a}	21.53±0.78^{a}	27.1±0.15^{a}	36.33±0.42^{ab}	39.00±0.31^{ab}	42.76±0.62^{b}	55.34±0.39^{b}	2479.17
LS4	23.23±0.15^{a}	33±0.31^{ab}	38.23±0.40^{ab}	44.20±0.53^{bc}	52.30±0.10^{cd}	56.90±0.57^{de}	69.65±0.67^{e}	1373.58
LS5	33.97±0.41^{c}	40.00±0.32^{ac}	52.67±0.52^{ab}	58.13±0.94^{ab}	62.23±1.09^{ab}	72.16±0.01^{b}	77.69±1.01^{d}	857.37
SB1	2.67±0.83^{a}	4.88±1.04^{a}	8.49±1.75^{a}	11.06±0.72^{a}	17.48±0.74^{a}	19.27±0.09^{a}	27.23±1.02^{b}	>3000
SB2	8.06±0.44^{a}	13.07±0.56^{a}	15.83±0.62^{a}	21.92±6.62^{a}	26.30±4.62^{a}	28.07±1.08^{a}	42.43±0.96^{a}	>3000
SB3	17.00±0.38^{b}	22±0.18^{bc}	26.3±0.44^{cd}	29.90±0.86^{ad}	37.13±0.56^{a}	48.033±0.41^{a}	51.83±0.80^{e}	2560.76
SB4	20.73±0.50^{c}	25.33±0.48^{b}	33.63±0.07^{ab}	41.90±0.57^{ab}	44.80±0.81^{a}	50.267±1.66^{a}	60.44±1.08^{d}	1971.63
SB5	22.27±0.22^{b}	29.80±0.23^{c}	36.0±0.87^{a}	43.43±0.82^{a}	52.20±0.12^{ac}	62.46±0.40^{cd}	71.40±0.36^{d}	1336.52
Asc. acid	53.67± 0.58^{a}	61.10±0.92^{a}	65.3±0.90^{a}	72.60±0.49^{a}	73.00±0.71^{a}	78.37±0.97^{a}	84.23±0.66^{a}	<200

LS1 = Hexane crude extract from leaves, LS2 = chloroform crude extract from leaves, LS3 = ethyl acetate crude extract from leaves, LS4 = acetone crude extract from leaves, LS5 = methanol crude extract from leaves, SB1 = hexane crude extract from stem-bark, SB2 = chloroform crude extract from stem-bark, SB3 = ethyl acetate crude extract from stem-bark, SB4 = acetone crude extract from stem-bark and SB5 = methanol crude extract from stem-bark. Asc. acid = Ascorbic acid. Values with different superscript letters are statistically different within a column.

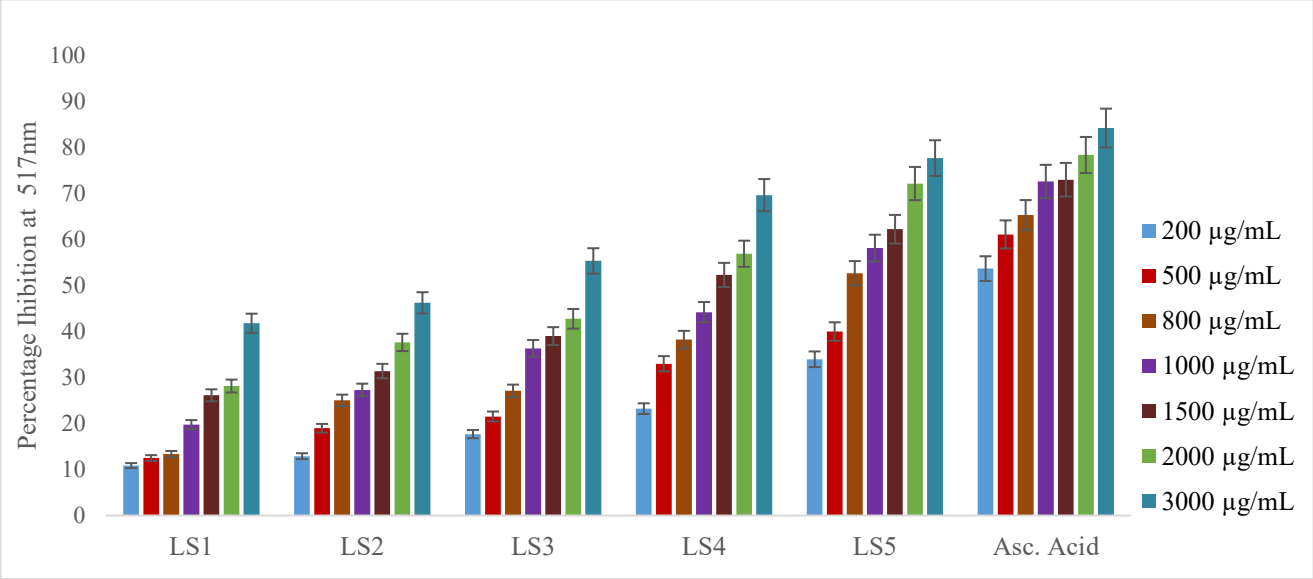

Figure 3: DPPH radical scavenging potential of various extracts from the leaves of *A. decipiens*.
LS1-LS5 = Refer to the footnote of Table 2: Asc. acid = Ascorbic acid.

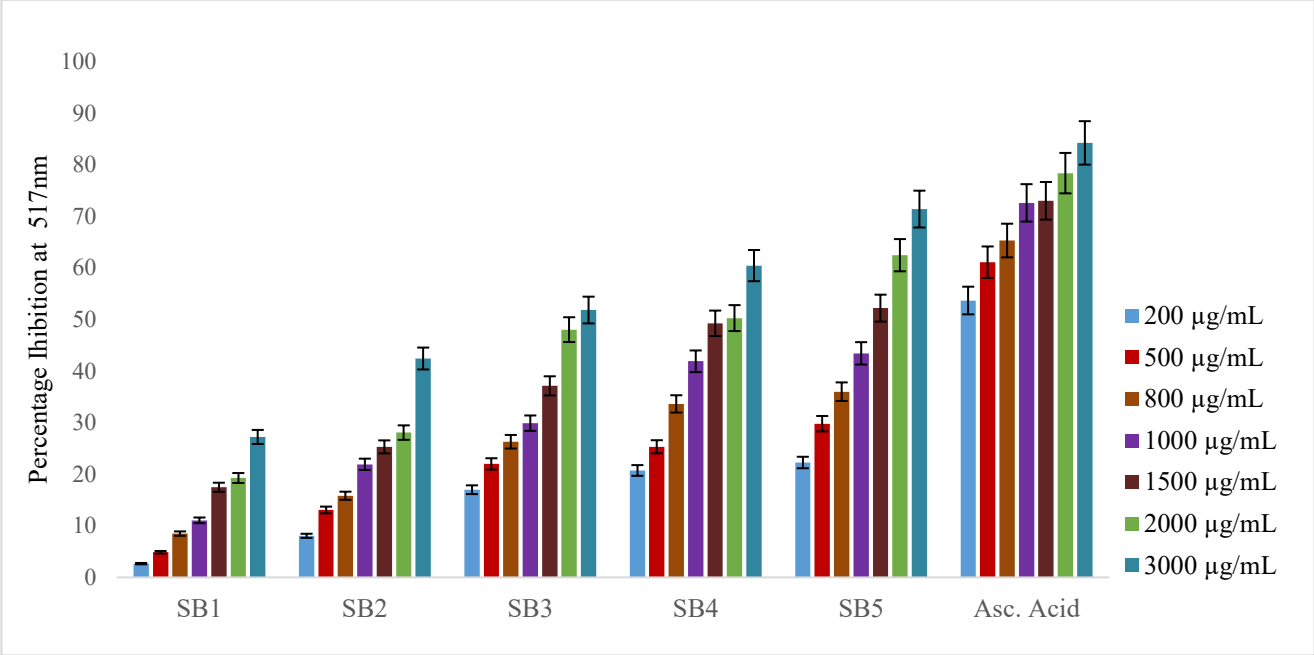

Figure 4: DPPH radical scavenging potential of various extracts from the stem-bark of *A. decipiens*.
SB1-SB5 = Refer to the footnote of Table 2: Asc. acid = Ascorbic acid.

Determination of total flavonoid contents (TFCs)

Extracts SB1-SB5 showed radical scavenging potentials of 27.23±1.02, 42.43±0.96, 51.83±0.80, 60.44±1.08, and 71.40±0.36%, respectively, at a concentration of 3000µg/mL (Table 2). Therefore, SB1 and SB5 showed lowest and highest radical scavenging potentials respectively among the extracts obtained from the stem-bark of *A. decipiens* at a concentration of 3000µg/mL. Here again, the same arguments such as non-polar nature of pentane and its extraction power for non-polar compounds and polar nature of methanol and its extraction power for polar compounds are applied for such a lower and higher scavenging potentials. All five extracts (SB1-SB5) obtained from the stem-bark of *A. decipiens* showed relatively lower scavenging potential at all concentrations compared to the positive control (Table 2). Overall, all ten extracts (LS1-LS5 and SB1–SB5) showed relatively lower scavenging potential compared to the positive control. However, at a concentration of 3000µg/mL, LS4, LS5, and SB5 showed significant scavenging potential, while LS3, SB3, and SB4 exhibited a moderate scavenging potential. For the ease of comparison, the bar graphs for scavenging potentials of LS1–LS5 and SB1–SB5 together with positive control are shown in Figure 3 and Figure 4, respectively.

The IC_{50} values for LS1-LS5, SB1-SB5, and the positive control (ascorbic acid) are also given in Table 2. The positive control exhibited an IC_{50} value of <200µg/mL. The IC_{50} values for LS1-LS5 were determined as >3000, >3000, 2479.17, 1373.58, and 857.37µg/mL, respectively. On the other hand, the IC_{50} values for SB1-SB5 were determined as >3000, >3000, 2560.76, 1971.63, and 1336.52µg/mL, respectively. The result revealed that all ten extracts (LS1-LS5 and SB1-SB5) had relatively much higher IC_{50} values. In other words, all ten extracts obtained from the leaves and stem-bark of *A. decipiens* exhibited relatively lower scavenging potential However, the methanol leaf extract (LS5) exhibited relatively highest scavenging potency among the extracts obtained from the leaves with an IC_{50} value of 857.37µg/mL followed by the acetone extract (LS4) with an IC_{50} value of 1373.58µg/mL. Similarly, the methanolic stem-bark extract (SB5) exhibited highest scavenging potency among the extracts obtained from the stem-bark and its IC_{50} value was determined as 1336.52µg/mL followed by the acetone extract (SB4) with an IC_{50} value of 1971.63µg/mL. On the other hand, LS1, LS2, SB1, and SB2 exhibited the lowest scavenging potential among all extracts with IC_{50} values of >3000µg/mL for each. Overall, all ten extracts (LS1-LS5 and SB1-SB5) exhibited relatively higher IC_{50} values compared to the positive control. In other words, all ten extracts (LS1-LS5 and SB1-SB5) showed relatively lower scavenging potential compared to the positive control. However, the methanolic extracts obtained from the leaves and stem-bark (LS5 and SB5) were found to be most potent among all extracts with IC_{50} values of 857.37and 1336.52µg/mL, respectively (refer Table 2).

The total phenolic contents (TPCs) of these ten extracts (LS1-LS5 and SB1-SB5) were determined, and the results are summarized in Table 3. The calibration curve of gallic acid is given in Figure 1 and it was used as standard to estimate the TPCs of various extracts. The TPCs of LS1-LS5 were found as 0.82±0.07, 0.83±0.12, 1.18±0.04, 14.99±0.80, and 15.81±1.96mg of gallic acid equivalent per gram dry weight of the extract (mg GAE/g DW), respectively. Therefore, the methanolic extract (LS5) obtained from the leaves had highest TPCs among the extracts from leaves followed by the acetone extract (LS4). Additionally, the acetone and methanol extracts (LS4 and LS5) obtained from the leaves showed comparable TPCs with each other (Table 3). On the other hand, although extracts LS3, LS2, and LS1 showed comparable TPCs with one another and they had much lower TPCs compared to LS4 and LS5 (Table 3). The TPCs of SB1-SB5 were determined as 1.13±0.19, 3.01±1.41, 21.14±1.05, 66.79±1.80, and 72.62±7.91mg of gallic acid equivalent per gram dry weight of the extract (mg GAE/g DW), respectively (Table 3). This result revealed that the methanolic extract (SB5) has highest TPCs among the extracts from stem-bark followed by the acetone extract (SB4). The ethyl acetate extract (SB3) had lower TPCs compared to SB5 and SB4. On the other hand, the dichloromethane and pentane extracts (SB2 and SB1) had much lower TPCs compared to SB5 and SB4 (Table 3). Extract SB1 had the lowest TPCs among the extracts obtained from the stem-bark (Table 3). Overall, the acetone and methanolic extracts (SB5 and SB4) had much higher TPCs among all extracts (Table 3).

Table 3: The total phenolic contents and total flavonoid contents of various extracts obtained from the leaves and stem-bark of *A. decipiens*.

Extracts	TPCs (mg GAE/g DW)	TFCs (mg QE/g DW)
LS1	0.82±0.07	13.49±1.44
LS2	0.83±0.12	16.48±8.50
LS3	1.18±0.04	21.00±7.35
LS4	14.99±0.80	18.57±4.60
LS5	15.81±1.96	16.43±2.58
SB1	1.13±0.19	15.71±1.08
SB2	3.01±1.41	18.38±7.91
SB3	21.14±1.05	20.48±2.75
SB4	66.79±1.80	48.34±11.61
SB5	72.62±7.91	49.05±4.54

LS1-LS5 & SB1-SB5 = Refer to the footnote of Table 2: Asc. acid = Ascorbic acid., TPCs = Total phenolic contents. TFCs = Total flavonoid contents

The total flavonoid contents (TFCs) of these ten extracts (LS1-LS5 and SB1-SB5) was determined and the results are summarized in Table 3. The calibration curve of quercetin is given in Figure 2 and it was used as standard to estimate the TFCs of various extracts. The TFCs of LS1-LS5 were determined as 13.49±1.44, 16.48±8.50, 21.00±7.35, 18.57±4.60, and 16.43±2.58mg of quercetin equivalent per gram dry weight of the extract (mg QE/g DW), respectively. Therefore, the ethyl acetate extract (LS3) had the highest TFCs among the extracts obtained from the leaves followed by LS4, LS2, LS5, and LS1 (Table 3). The TFCs of LS2, LS4, and LS5 were comparable to one another (Table 1). Extract, LS1 showed lowest TFCs among the extracts obtained from the leaves but its TPCs were significant. The TFCs of SB1-SB5 were found to be 15.71±1.08, 18.38±7.91, 20.48±2.75, 48.34±11.61, and 49.05±4.54mg of quercetin equivalent per gram dry weight of the extract (mg QE/g DW), respectively. This result revealed that extracts SB4 and SB5 showed higher TFCs followed by SB3, SB2, and SB1 (Table 1). Additionally, the acetone and methanolic extracts (SB4 and SB5) obtained from the stem-bark showed comparable TFCs to each other (Table 3). Similarly, dichloromethane and ethyl acetate extracts (SB2 and SB3) showed comparable TFCs to each other (Table 3) but they had much lower TFCs compared to SB4 and SB5. The pentane extract (SB1) showed lowest TFCs among the extracts obtained from the stem-bark but had significant TFCs. Overall, the acetone and methanolic extracts (SB5 and SB4) obtained from the stem-bark showed much higher TFCs among all extracts (Table 3).

As stated previously *A. decipiens* has not been explored for biological, pharmacological and phytochemical studies. Particularly, reports on the *A. decipiens* species collected from the Kingdom of Eswatini have not been available in the literature. However, the presences of various classes of compounds, including flavonoid and phenolic compounds have previously been identified from other species of the Sapindaceae family of the Allophylus genus (Kumar et al., 2010; Ali et al., 2011; Zhang et al., 2012; Oladosu et al., 2013;

Oladosu et al., 2015; Abiodun et al., 2021; Andrea et al., 2021; Jemal et al., 2022; Ejike et al., 2023; Nkeoma et al., 2024; Diogenes et al., 2015). Our result has good agreement with these reports that in the present study also we confirmed the presence of flavonoid and phenolic compounds. Additionally, other species of the Sapindaceae family of the Allophylus genus have previously been investigated for their DPPH radical scavenging activity. For example, petroleum ether, chloroform, ethyl acetate, methanol and water extracts obtained from the leaves of *Allophylus serratus* showed a moderate to significant DPPH scavenging activity of 35.74±0.01-74.70±0.12% at a concentration range of 100-800µg/mL (Jemal et al., 2022). In another report, essential oils have been obtained separately from the leaves, twigs, and roots of *Allophylus spicatus* and the DPPH radical scavenging assay of these essential oils showed a half-minimal inhibition concentration (IC_{50}) of 0.4746, 0.4172, and 0.4156mg/mL, respectively (Ejike et al., 2025). In another report, an aqueous methanolic crude extract (1:1, v/v) was obtained from the leaves of *Allophylus edulis* by maceration technique (Andrea et al., 2021). Additionally, hexane, dichloromethane, ethyl acetate, and n-butanol fractions were also obtained from this aqueous methanolic crude extract by solvent-solvent partition (Andrea et al., 2021). Similarly, hexane, dichloromethane, ethyl acetate, and n-butanol fractions were also obtained separately by successive extraction of leaves of *Allophylus edulis* using Soxhlet extractor (Andrea et al., 2021). All the above extracts and fractions obtained from the leaves of *Allophylus edulis* have been evaluated for their antioxidant activity using DPPH radical scavenging assay and they showed half-minimal effective concentrations (EC_{50}) in the range of 43.6±2.60–698.7±14.70mg/mL in the DPPH assay (Andrea et al., 2021).

4. CONCLUSION

Pentane, dichloromethane, ethyl acetate, acetone, and methanol extracts were obtained separately from leaves and stem-bark of *A. decipiens*. The radical scavenging potential of leaves and stem-bark extracts were found to be in the ranges of 10.85±0.79-77.69±1.01% and 2.67±0.83-71.40±0.36%, respectively at a concentration range of 200-3000 µg/mL. Additionally, the IC_{50} values of these ten extracts and the positive control ascorbic acid were determined. The positive control showed an IC_{50} value of <200 µg/mL. The methanolic extracts obtained from the leaves and stem-bark were identified as the most potent extracts with IC_{50} values of 857.37 and 1336.52µg/mL, respectively. In addition, the TPCs and TFCs of these extracts were also quantified using gallic acid and quercetin, respectively as standards. The acetone and methanolic extracts obtained from the leaves and stem-bark had much higher TPCs and TFCs compared to other extracts. From this study, we concluded that *A. decipiens* exhibited a weak to moderate DPPH radical scavenging potential. The acetone and methanolic extracts obtained from the leaves and stem-bark showed significant TPCs and TFCs. *A. decipiens* has not been investigated previously for biological, pharmacological, and phytochemical studies. Therefore, further studies such as various bioassays on crude extracts from various parts of this plant, isolation and characterization of various parts of *A. decipiens* and bioassays on the isolated pure compounds are recommended.

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Authors' Contributions

Manoharan Karuppiah Pillai: Proposed idea, supervised the research work, drafted, reviewed and edited the manuscript.
Dlamini Mongisi Nkosephayo: Conceived the idea, collected the data, performed the experiment and drafted the manuscript.
Justice Mandlenkhosi Thwala: Oversaw the research work, reviewed and edited the manuscript.

Ethical Approval

In this article, as per the plant regulations followed in the Department of Chemistry, University of Eswatini, Kwaluseni Campus, The Kingdom of Eswatini, Southern Africa; the authors observed the antioxidant potential of extracts from *Allophylus decipiens*. The ethical guidelines for plants & plant materials are followed in the study for observation, identification & experimentation.

Informed Consent

Not applicable.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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Data and materials availability

All data associated with this study are present in the paper.

REFERENCES

1. Abiodun HA, Temitope AI, Omolara FY. Acute toxicity and antimalarial studies of extract of *Allophylus spicatus* in animals. Toxicol. Res, 2021, 37: 345–354.
2. Ali MS, Ali MI, Ahmed Z, Onocha PA. Two new prenyl flavanones from *Erythrina sigmoidea*. Nat. Prod. Com, 2011, 6: 1099-1102.
3. Andrea MS, Elisandra T, da Silva SM, Marina P, Lara TS. Polyphenol content and antioxidant potential of *Allophylus edulis*. (A. St.-Hil. Et Al.) Hieron. Ex Niederl. and *Cupania vernalis* Cambess. (Sapindaceae). Rev. Arvore, 2021, 45(e4507): 1-11.
4. Boon R. Pooley's trees of eastern South Africa. Flora and Fauna Publications Trust, Durban, 2010.
5. Burkill HM. The useful plants of west tropical Africa: vol. 5. Families: S-Z Addenda. Royal Botanic Gardens: Kew, Richmond, United Kingdom, 2000, 686.
6. Diogenes JCC, Mariana OB, Rejane MS, da Silva SI, de Oliveira AFM. Fatty acid composition of seeds and chemotaxonomic evaluation of sixteen Sapindaceae species. Chem. Biodivers, 2015: 12: 1271-1280.
7. Ejike OO, Patricia AO, Muhammad SA, Oluwakayode OO, Michael GI, Godfrey OE, Mehreen L. Antibacterial activity of isolated compounds from *Allophylus spicatus* (Poir.) Radlk (Sapindaceae). J. Biologically Act. Prod. Nat, 2023, 13: 380 – 389.
8. Ejike OO, Patricia,AO, Godfrey OE, Oluwakayode OO, Michael GI, Adeniji AA, Janet EB, Muhammad SA. Volatile chemical composition and antioxidant potential of essential oils isolated from leaves, twigs and roots of *Allophylus spicatus* (Radlk). Discover Plants, 2025, 2: 1-13.
9. Exell AW, Fernandes A. Wild, H. (eds.) Flora Zambesiaca: Royal Botanic Gardens, Kew. 1966, Volume 2, Issue 2, pp. 353-653.
10. Freisesleben SH, Soelberg J, Nyberg NT, Jager A.K. Determination of the wound healing potentials of medicinal plants historicallyused in Ghana. Hindawian J. Evid. Based Compl. Altern. Med, 2017, 17: 1-6.
11. Germishuizen G, Meyer NL. (eds.) Plants of Southern Africa an annotated checklist. Strelitzia 14: National Botanical Institute, Pretoria, 2003, pp. 1-1231.
12. Goldblatt P, Manning JC, Cape Plants: A conspectus of the Cape Flora of South Africa. Strelitzia 9: National Botanical Institute, Pretoria & Missouri Botanical Garden, Missouri, 2000.
13. Govaerts, R. World Checklist of Seed Plants 529. MIM, Deurne, 1995, 1(1, 2): pp. 1-483.
14. Harrington MG, Gadek PA. Phylogenetic of hop bushes and pepper flowers (*Dodonaea, Diplopeltis*-Sapindaceae), based on nuclear ribosomal ITS and partial ETS sequences incorporating secondary structure models. Aust. Syst. Bot, 2010, 23: 431-442.
15. Jemal K, Sandeep BV, Sudhakar P. Phytochemical screening and in vitro antioxidant activity analysis of leaf and callus extracts of Allophylus serratus (ROXB) KURZ. Jordan J. Pharm. Sci, 2022, 15: 51-69.
16. Kumar M, Rawat P, Dixit D, Mishra D, Gautarn A. Antiostereoporotic Constituents from Indian Medical Plants. Phytomedicine, 2010, 17: 993-999.
17. Leenhouts PW. A conspectus of the genus Allophylus (Sapindaceae). The problem of the complex species: Blumea: *Biodiversity, evolution and biodiversity of plants*, 1967, Volume 15, Issue 2, pp. 301-358.
18. Matamane PR, Pillai MK, Magama S. DPPH radical scavenging activity of extracts from *Urtica urens* (Urticaceae). J. Med. Plants Res, 2020: 14: 232–238.
19. Maura F, Andrea G, Annalisa T. Optimisation of assay conditions for the determination of antioxidant capacity and polyphenols in cereal food components. J. Food Compos. Anal, 2013: 30: 94-101.

20. Mokoroane KT, Pillai MK, Magama S. 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of extracts from *Aloiampelos striatula*. Food Res, 2020: 4: 2062–2066.
21. Mpopo MS, Pillai MK, Mekbib SB. 2,2-Diphenyl-1-picrylhydrazil radical scavenging activity of extracts from roots and leaves of *Searsia burchellii*. Food Res, 2021: 5: 235 – 239.
22. Nkeoma NO, Nwando JN, Chidimma MM, Francesca OO, Deborah AE, Faithful OU. Comparative phytochemical and antioxidant studies of the hexane and ethyl acetate fractions of the methanol extracts of the stem bark of *Allophylus africanus*. J. Clin. Basic Res, 2024, 4: 1884-1892.
23. Oladosu IA, Balogun SO, Ademowo GO. Phytochemical screen-ing, antimalarial and histopathological studies of *Allophylus africanus* and *Triagia benthamii*. Chin. J. Nat. Med, 2013, 11: 371-376.
24. Oladosu IA, Balogun SO, Zhinquang L. Chemical Composition of *Allophylus africanus.* Chin. J. Nat. Med, 2015, 13: 133-141.
25. Pillai MK, Keketso M, Matamane RP. Antioxidant activity of extracts from *Bidens pilosa*-A medicinal plant from the Kingdom of Lesotho. Fine Chem. Eng. (FCE), 2023a: 4: 110-124.
26. Pillai MK, Mthimkhulu BL. Antioxidant activity and phytochemical analysis of extracts from *Ximenia caffra*: A Swazi medicinal plant. Int. J. Herb. Med, 2024: 12: 11-16.
27. Pillai MK, Samkelisiwe NS. Antioxidant potential and phytochemical screening of extracts from *Senegalia nigrescens* - A traditional Swazi medicinal plant. Fine Chem. Eng. (FCE), 2024: 5: 361-368.
28. Pillai MK, Santi LI, Magama S. DPPH radical scavenging activity of extracts from *Rhamnus prinoides*. J. Med. Plants Res, 2019: 13: 329-334.
29. Pillai MK, Simelane T. Antioxidant activity and phytochemical analysis of extracts from *Acacia gerrardii*: A medicinal plant from the Kingdom of Eswatini. Int. J. Adv. Biol. Biomed. Res, 2025: 13: 48-60.
30. Pillai MK, Thebe P, Matamane RP. Antioxidant activity of extracts from *Xanthium strumarium* – A medicinal plant from the Kingdom of Lesotho. Int. J. Plant Bas. Pharm, 2023b: 3: 114–122.
31. Raimondo D, von Staden L, Foden W, Victor JE, Helme NA, Turner RC, Kamundi DA, Manyama PA. Red List of South African Plants. Strelitzia 25: South African National Biodiversity Institute, Pretoria, 2009.
32. Sara HF, Jens S, Nils TN, Anna KJ. Determination of the wound healing potentials of medicinal plants historically used in Ghana. Evid. Based Compl. Altern. Med, 2017, Article ID 9480791: 1-6.
33. Sascha CTN, Herbert WJ. Optimized DPPH assay in a detergent-based buffer system for measuring antioxidant activity of proteins. MethodsX, 2014: 1: 233–238.
34. Selepe TS, Pillai MK. Evaluation of antioxidant activity of extracts from *Leucosidea sericea*. Herba Pol, 2022: 68: 10–18.
35. Sharma OP, Bhat TK. DPPH antioxidant assay revisited. Food Chem, 2009: 113: 1202–1205.
36. Victor JE, van Wyk AE. *Allophylus decipiens* (Sond.) Radlk. National Assessment: Red List of South African Plants, 2005.
37. Zhang X, Xiang-Hai C, Xiao-Dong L. Chemical constituents of *Allophylus longipes*. Chin. J. Nat. Med, 2012, 10: 36-39.