Wild plants remain to be a major source of traditional medicine in rural areas of North-Eastern (NE) region of India. In this part of India several wild and aromatic plants have traditionally been used as medicine against several health complications such as heart attack, cancer, diabetes, malaria, jaundice, inflammation and wound healing\cite{1-3}. Despite of remarkable progress in the field of medical sciences and synthetic medicines more than 25% of commercial drugs/chemicals come directly or indirectly from plants. According to World Health Organization (WHO) report, more than 80% population of developing countries like India depends on traditional medicine for daily healthcare needs because of its easy accessibility, less preparation costs and absence of any undesirable side effects\cite{4,5}. Over the last few decades several potent chemotherapeutic drugs and molecules have been derived from plants. Out of 20% plant species studied scientifically worldwide, only about 6% are screened for its pharmaceutical potential\cite{6,7}. Screening of various phytochemical constituents and antioxidant properties including heavy metal is a major part of pharmaceutical drug discovery. Although NE India is full of medicinal plants very few studies have been carried out to explore its phytochemical contents and antioxidant properties\cite{8-10}. In addition to antioxidant activities, presence of metallic elements at certain concentration is beneficial to both plants and animals\cite{11}. Trace metals serve either as cofactors or activators of enzymes forming enzymes/substrate-metal complex and exert catalytic property or regulators of nerve transmission, muscle contraction, osmotic pressure and salt-water balance\cite{12}. It is known that several elements such as cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), selenium (Se) and zinc (Zn) are essential compounds required for various biochemical and physiological functions. Inadequate supply of these micro-nutrients results in variety of deficiency diseases\cite{13}. On the other hand, heavy metals like arsenic (As), cadmium (Cd), Cr, lead (Pb) and mercury (Hg) do not have any well-known

**Phytochemical Analysis and Antioxidant Activity of *Hodgsonia heteroclita* (Roxb)**

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Swargiary and Brahma: Phytochemical Screening of *Hodgsonia heteroclita*

*Hodgsonia heteroclita* (Roxb) is an important medicinal plant of Northeast India. The fruit pulp of *H. heteroclita* is traditionally used as antidiabetic medicine. Due to its pharmacological properties, the present study was aimed to investigate the phytochemical, antioxidant and heavy metal contents of the plant. Preliminary phytochemical screening revealed the presence of phytochemicals like phenolics, flavonoids, alkaloids, saponins and steroids. The heavy metal content when analysed using Analytik Jena AAS vario-6 Graphite furnace spectrometer revealed highest content of iron followed by chromium and copper. Two toxic metals, cadmium and lead were found within the acceptable range. The antioxidant capacities of alcoholic extract of plant was studied by 1,1-diphenyl-2-picryl-hydrazyl, ferric reducing antioxidant power assay, lipid peroxidation scavenging activity assay and phosphomolybdic acid assay showed significant free radical scavenging potential. Pearson correlation revealed strong relationship between the phytochemical contents and antioxidant capacity of the plant. The present study revealed that the plant extract possessed good antioxidant activity and less quantity of toxic metals, which therefore can be used as a source of natural free radical scavenger. However, further study need to be carried out to know its mode of action.

Key words: Wild plants, phytochemicals, antioxidant, trace elements, Assam

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biological role and are known to be systemic toxicant that induces multiple organ damages and diseases\[14\].

_Hodgsonia heteroclita_ (Roxb), family Cucurbitaceae, is a perennial, climber plant that reaches up to 30 m in length and grows well in hilly terrain of southern Asia such as Bangladesh, Bhutan, Cambodia, Laos, Myanmar, Thailand, Vietnam and India. It is a deciduous plant having a long life span of up to 70 y\[15\]. The flower and fruit setting of plant is temperature dependent and flowers open only during the night time. In the NE region of India, the plant is mainly distributed in the hilly areas of Assam, Arunachal Pradesh, Meghalaya, Nagaland and Mizoram. Distributed within the geographical locations of 89° 50/E to 96° 10/E and 24° 30/N to 28° 10/N, Assam is one among the richest biodiversity zones of NE India with diverse ethnicity and rich flora and fauna. Several medicinal and wild edible plants have been studied for its pharmacological properties from this part of India\[16,17\]. Inhabited with different ethnic groups like Bodos, Rabhas, Mishing and Garo this part of India is rich in traditional knowledge of healthcare systems. _H. heteroclita_ is one such traditionally used medicinal plant, the fruit extract of which is used as antihyperglycemic agent\[18\]. The plant is also reported to be used against various ailments like nose complain, fever, helminth and bacterial infections\[19\]. Although the fruit extract of _H. heteroclita_ is used by the local people as antihyperglycemic agent, to the best of our knowledge no scientific report has been published on the antioxidant activity and heavy metal content of this plant. In view of its medicinal value, the present study was designed to explore the phytochemical and heavy metal content and antioxidant potential of _H. heteroclita_.

MATERIALS AND METHODS

Ascorbic acid (AA), gallic acid, quercetin, aluminum chloride (AlCl₃), ferric chloride (FeCl₃), Folin-Ciocalteu, bovine serum albumin (BSA), oxalic acid, thiobarbituric acid (TBA), 1,1-diphenyl-2-picryl-hydrazyl (DPPH), trichloroacetic acid (TCA), 2,4,6-tri(2-pyridyl)-s-triazine (TPTZ), sulphuric acid (H₂SO₄), hydrochloric acid (HCl), ammonium molybdate, potassium ferricyanide (K₃Fe(CN)₆), sodium dodecyl sulphate (SDS), chloroform and alcohols were purchased from HiMedia Laboratories, Mumbai and SRL Pvt. Ltd., Mumbai, India. All the chemicals used were of analytical grade.

Collection, identification and preparation of plant extract:

Fresh fruits of _H. heteroclita_ were collected from nearby jungles of Kokrajhar town and were identified in the Department of Botany, Bodoland University. After collection, the fruits were washed with distilled water, pulp extracted and completely dried in hot air oven at 50°. Dried samples were ground to a powder and soaked in 80% methanol. Solution was filtered after 24 h of soaking and fresh solvent was added. The process was repeated four times and the filtrate obtained was evaporated in a rotary evaporator. Dry, semi-solid extracts (crude extract) obtained was kept at 4° for further use.

Heavy metal analysis:

Heavy metal content of plant was analysed following the method reported by Welz and Sperling\[20\]. Briefly, 1 g of plant powder was digested with concentrated HNO₃:HCl (3:1 ratio) at 85° for 3 h. After adding 1 ml of concentrated HClO₄, the solution was filtered and diluted to 50 ml of distilled water. An Analytik Jena AAS vario-6 Graphite furnace spectrometer furnished with PC-controlled 6-piece lamp turret and argon gas supply was used for all of the absorption measurements of metal contents of the plant. The elements instrumental conditions are given in Table 1.

Qualitative phytochemical study:

The presence of phytochemicals such as flavonoids, phenolics, reducing sugar, saponins, steroids and tannins in the plant was analysed following standard protocols\[21,22\]. For anthraquinones, 100 mg of plant extract was boiled with 10 ml of 1% HCl and filtered. Filtrate shaken with 3 ml of benzene and 2 ml of 10% ammonia solution and mixture was filtered. Presence of anthraquinone was confirmed by the presence of pink, violet or red colour in the ammonical phase of the solution. Presence of cardiac glycoside was detected when 5 ml (10 mg/ml methanol) of plant extract mixed with 2 ml glacial acetic acid and few drops of FeCl₃ were added. Appearance of a brown ring at the interface of solution after the addition of 1 ml of concentrated H₂SO₄ established the presence of cardiac glycosides. Presence of flavonoid was confirmed by the appearance of yellow colour in a solution of 1 ml of plant extract and few drops of 1% AlCl₃ solution.

Phenolic content of plant was detected when 0.5 g of plant extract dissolved in water, mixed with a few drops of 5% FeCl₃ solution, appearance of a dark green
colour indicated the presence of phenolic compounds. For phlobatannin detection, 50 mg of extract was boiled in 1% HCl and deposition of a red precipitate indicated its presence. The presence of free reducing sugars was detected by the appearance of a red precipitate in a solution of 2 ml of plant extract (50 mg/ml) when mixed with equal volumes of Fehling’s solution A and B. Saponins were detected by boiling 50 mg extract with 10 ml distilled water, filtered and was mixed with distilled water and shaken vigorously until a stable persistent froth is obtained. The frothing was mixed with 2 to 3 drops of olive oil and shaken vigorously. The formation of emulsion indicated the presence of saponins. Presence of tannins was detected by boiling 50 mg plant extract with 5 ml of distilled H$_2$O, and addition of a few drops of 1% AlCl$_3$ turned the solution into blue-black or blue green colour. Presence of terpenoids was confirmed by mixing 5 ml (1 mg/ml) of extract with 2 ml of chloroform and 3 ml of H$_2$SO$_4$. A reddish brown colour at the interface confirmed the presence of terpenoids.

**Quantitative phytochemical study:**

The presence of total carbohydrate content in the plant extract was estimated following the anthrone method$^{[23]}$. Results were expressed as µg sugar/mg crude extract using the calibration curve of glucose ($y=0.0017x$; $R^2=0.9996$). The protein content of the plant was estimated following Lowry’s method$^{[24]}$. Results were expressed as µg protein/mg plant extract using the calibration curve of BSA ($y=0.0061x$; $R^2=0.9968$). The vitamin-C content was estimated titrimetrically$^{[23]}$. Briefly, 1 ml of 1 mg/ml of AA solution in 4% oxalic acid and the plant extract was taken in separate conical flasks and 10 ml of 4% oxalic acid was added in each flask. The mixture was then titrated against 2,6-dichlorophenol indophenol till the end-point colour pink was observed and the amount of dye consumed was noted. Results expressed as µg ascorbic acid equivalent (AAE)/mg crude extract.

The total phenolic content (TPC) of H. heteroclita is estimated by Swin and Hills with slight modification$^{[25,26]}$. Briefly, 1 ml of plant extracts (200 µg/ml) was mixed with 3 ml of 10% Folin-Ciocalteu reagent and 0.5 ml of sodium carbonate (10% w/v). The mixture was vortexed for 15 s and incubated at 40° for 30 min for colour development. The absorbance was measured at 765 nm. The amount of TPC was calculated from a calibration curve of gallic acid ($y=0.0161x$; $R^2=0.9963$) and the results expressed as mg gallic acid equivalent (GAE)/mg crude extract.

The flavonoid content was determined by mixing 1 ml of plant extract (two concentrations 0.25 and 0.5 mg/ml, prepared in 80% ethanol) with 0.5 ml of 2% AlCl$_3$(prepared in 80% ethanol). The assay mixture was made 3 ml by adding distilled water. The mixture was incubated at room temperature for 30 min and the formation of yellow colour was measured at 430 nm$^{[27]}$. The total flavonoid content was calculated from the standard curve (y=0.01x; $R^2=0.9786$) of quercetin (concentration 5-25 µg/ml) and the values represented as µg quercetin equivalent (QE)/mg of crude extract.

**Total antioxidant activity (phosphomolybdate assay):**

The total antioxidant capacity (TAC) of the plant extract was estimated following phosphomolybdate assay$^{[28]}$. Heteroclita. Table 1: Instrumental analytical conditions of AAS vario-6 graphite furnace elements

<table>
<thead>
<tr>
<th>Element</th>
<th>Wavelength (nm)</th>
<th>Slit width (nm)</th>
<th>Atomisation temperature (°C)</th>
<th>Matrix modifiers</th>
<th>Interference wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr</td>
<td>357.9</td>
<td>0.8</td>
<td>2100-2200</td>
<td>NH$_4$H$_2$PO$_4$</td>
<td>Fe 358.1, Nb 358.0</td>
</tr>
<tr>
<td>Mn</td>
<td>279.5</td>
<td>0.2</td>
<td>1600-1650</td>
<td>Mg(NO$_3$)$_2$+Pd(NO$_3$)$_2$</td>
<td>Mg 279.5, Fe 279.5, Pb 280.2</td>
</tr>
<tr>
<td>Fe</td>
<td>248.3</td>
<td>0.2</td>
<td>1850-2050</td>
<td>Mg(NO$_3$)$_2$</td>
<td>--</td>
</tr>
<tr>
<td>Cu</td>
<td>324.8</td>
<td>0.8</td>
<td>1800-1900</td>
<td>--</td>
<td>Ni 324.3, Mn 324.9, Pd 324.3, Ag 324.8, Eu 324.8</td>
</tr>
<tr>
<td>Zn</td>
<td>213.9</td>
<td>0.8</td>
<td>1000-1100</td>
<td>Pd(NO$_3$)$_2$</td>
<td>Cu 213.9, Te 214.3, As 214.4, Fe 213.6, Fe 213.9</td>
</tr>
<tr>
<td>Cd</td>
<td>228.8</td>
<td>0.8</td>
<td>900-1200</td>
<td>NH$_4$H$_2$PO$_4$+Mg(NO$_3$)$_2$</td>
<td>As 228.9, Fe 228.8</td>
</tr>
<tr>
<td>Pb</td>
<td>217</td>
<td>0.5</td>
<td>1200-1350</td>
<td>Pd(NO$_3$)$_2$+Mg(NO$_3$)$_2$</td>
<td>Cu 216.5, Fe 216.7, Ni 216.6, Sb 217.6, Pt 216.5</td>
</tr>
</tbody>
</table>
One millilitre of the extract (500 µg/ml) was mixed with 1 ml distilled water and 1 ml reagent solution (600 mM sulphuric acid, 28 mM sodium phosphate, and 4 mM ammonium molybdate). The reaction mixture was incubated at 95° for 30 min and absorbance was measured at 695 nm against blank solution. TAC was expressed as µg AAE/mg plant extract.

**DPPH radical scavenging activity:**

The DPPH scavenging activity of the extract was estimated by mixing 2 ml of DPPH reagent (0.135 mM, prepared in methanol) with 1 ml of AA and 1 ml plant extracts (25-500 µg/ml). After 30 min of incubation at room temperature decrease in absorbance was observed at 517 nm. The scavenging activity of plant extract was calculated using Eqn., DPPH scavenging activity (%)= (Abs control–Abs sample/Abs control)×100, where, Abs control is the absorbance of DPPH and methanol, Abs sample is the absorbance of DPPH and plant extract or AA.

**Ferric reducing antioxidant power assay (FRAP assay):**

One millilitre of AA (5-100 µg/ml) and plant extract (25-500 µg/ml) was mixed with 2 ml of FRAP reagent, which is a mixture of 10 ml acetate buffer (pH 3.6), 1 ml of 10 mM TPTZ solution in 40 mM HCl and 1 ml of 20 mM FeCl₃. After 30 min of incubation at 50° the absorbance was measured at 593 nm. The FRAP activity of plant extracts were compared with that of the standard AA.

**Lipid peroxidation scavenging activity assay (TBARS assay):**

TBARS assay was done to measure the lipid peroxide formation using egg yolk homogenate as lipid-rich media. Lipid peroxidation was induced in 0.1 ml of egg homogenate (10% v/v) by adding 1 ml plant extract/standard (concentration range 0.05-1.0 mg/ml) and 0.05 ml of 75 mM FeSO₄. The mixture was incubated for 30 min at 37°. Then, 1 ml each of 10% TCA and 0.8% (w/v) TBA in 1.1% SDS was added and the resulting mixture vortexed and heated for 1 h at 95°. After cooling, 3 ml of butanol was added to each tube and centrifuged at 3000 rpm for 10 min. The absorbance of the organic upper layer was measured at 532 nm. Inhibition of lipid peroxidation (%) by the extract was calculated using Eqn., percent inhibition = (Abs control–Abs sample/Abs control)×100, where, Abs control is the absorbance of the reaction mixture without the sample or standard, Abs sample is the absorbance of reaction mixture with sample/standard.

**Statistical analysis:**

All data are presented as mean±standard deviation (SD) for at least three replications for each experiment. The results are considered to be significant at P<0.05. All statistical analysis was performed in MS-Excel and the graphs were drawn using OriginPro8 software. Pearson correlation was done using IBM SPSS Statistics 23.

**RESULTS AND DISCUSSION**

The dry weight of the plant and its moisture content, methanolic crude extract and heavy metal content of *H. heteroclita* is shown in the fig. 1. The present study showed that the percentage moisture content, dry weight and methanol extract recovered from 100 g of fresh fruit pulp were 86.72%, 13.27 g and 2.44 g, respectively (fig. 1a and b). The semi-solid plant extract recovered was yellow in colour having strong bitter taste and dissolved completely in water. Qualitative study showed the presence of phytochemical contents such as phenolics, flavonoids, alkaloids, saponins,
glycosides etc. in the methanol extract of *H. heteroclita*. The presence of high quantity of phytochemicals including secondary metabolites such as phenolics and flavonoids, might contribute to the pharmacological activity possessed by certain plants\(^\text{(32)}\). Flavonoids are important secondary metabolites that exhibit medicinal properties such as antioxidant, antiinflammatory, anticancer, antibacterial and antiviral activity\(^\text{(33)}\). Table 2 showed the phytochemical contents of the tested plant. Qualitative analysis of *H. heteroclita* revealed the presence of alkaloids, flavonoids, phenol, reducing sugar, saponins, steroids, tannins, terpenoids and cardiac glycosides while anthraquinone and phlobatannins were found to be absent. In addition, the present study revealed high concentrations of carbohydrate, protein, vitamin C, TPC and TFC in the plant (Table 3). Concentration of carbohydrate was found to be highest 445.11±3.09 µg/mg extract followed by protein 73.95±2.52 µg/mg extract. Similarly, the concentrations of TPC, TFC and AA were found to be 43.56±2.09, 6.51±0.51 and 24.46±1.13 µg/mg extract, respectively (Table 3). Presence of high concentration of carbohydrates and proteins indicate high nutritional value of the plant. Vitamin C or AA is an important biomolecule with free radical scavenging property. Although most mammals can synthesize AA, humans cannot, due to defective L-gulono-1,4-lactone oxidase, the last enzyme in the AA biosynthetic pathway. Therefore, humans need to obtain AA from dietary sources\(^\text{(34)}\). Various phytochemical studies have revealed the concentration of AA ranging from 8 to 1426 µg/g fresh weight\(^\text{(35)}\).

The trace element contents in the fruit pulp of *H. heteroclita* are given in the fig. 1c. The different trace elements such as Mg, Zn, Mn, Pb, Cu, Fe, Cr and Cd estimated in the present study ranged from 0.011 to 11.48 mg/kg plant powder. Trace elements are important molecules for normal functioning of many biological systems. Normal functioning of many proteins, enzymes, metabolic and catabolic activities is regulated by the presence of trace elements. For instance, Fe is an important trace element of biological importance deficiencies of which may lead to vital physiological imbalances in the body. According to WHO estimates, worldwide about 700 million people are suffering from Fe deficiency\(^\text{(36)}\). In the present study, out of eight trace elements, Fe was found to

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**Table 2: Phytochemical Screening of Methanol Extracts of *H. heteroclita***

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Reagents/chemicals</th>
<th>Observation</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>Wagner’s reagent</td>
<td>Brown/red precipitate</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>FeCl3</td>
<td>Blue green colour</td>
<td>+</td>
</tr>
<tr>
<td>Phenol</td>
<td>Folin-Ciocalteu</td>
<td>Blue green colour</td>
<td>+</td>
</tr>
<tr>
<td>Reducing sugar</td>
<td>Fehling’s solution</td>
<td>Orange red precipitate</td>
<td>+</td>
</tr>
<tr>
<td>Saponins</td>
<td>Distilled water heating</td>
<td>Frooting seen</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>Liebermann-Burchard test</td>
<td>Bluish green</td>
<td>+</td>
</tr>
<tr>
<td>Tannins</td>
<td>FeCl3</td>
<td>Blue green precipitate</td>
<td>+</td>
</tr>
<tr>
<td>Terpenoids</td>
<td>CHCl3+H2SO4</td>
<td>Reddish brown ring</td>
<td>+</td>
</tr>
<tr>
<td>Anthraquinone</td>
<td>C6H6+NH3</td>
<td>Red, pink or violet colour</td>
<td>-</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>FeCl3+H2SO4</td>
<td>Brown ring</td>
<td>+</td>
</tr>
<tr>
<td>Phlobatannins</td>
<td>HCl+boil</td>
<td>Red precipitate</td>
<td>-</td>
</tr>
</tbody>
</table>

Qualitative detection of phytochemicals with ‘+’ means present and ‘-’ means absent

**Table 3: Phytochemical Content and IC\(_{50}\) Values of Free Radical Scavenging Assays of Methanol Extract of *H. heteroclita***

<table>
<thead>
<tr>
<th>Phytochemicals contents/IC(_{50}) values</th>
<th><em>H. heteroclita</em></th>
<th>Standard chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates (µg/mg extract)</td>
<td>445.11±3.09</td>
<td></td>
</tr>
<tr>
<td>Protein (µg/mg extract)</td>
<td>73.95±2.52</td>
<td></td>
</tr>
<tr>
<td>Vitamin-C (µg AAE/mg extract)</td>
<td>8.00±0.04</td>
<td></td>
</tr>
<tr>
<td>TPC (µg GAE/mg extract)</td>
<td>43.56±2.09</td>
<td></td>
</tr>
<tr>
<td>TFC (µg QE/mg extract)</td>
<td>6.51±0.51</td>
<td></td>
</tr>
<tr>
<td>TAA (µg AAE/mg extract)</td>
<td>24.46±1.13</td>
<td></td>
</tr>
<tr>
<td>DPPH, IC(_{50}) (µg)</td>
<td>1284.93±31.20</td>
<td>6.31±0.13*</td>
</tr>
<tr>
<td>TBARS, IC(_{50}) (µg)</td>
<td>431.16±36.37</td>
<td>100.17±3.07*</td>
</tr>
</tbody>
</table>

Values are expressed as mean±SD with three replications (n=3) for each experiments, * ascorbic acid as standard chemical
be highest (11.48±0.386 mg/kg dry plant powder), while Mn showed lowest concentration (0.011±0.001 mg/kg) (fig. 1c). Cu and Cr were present in high concentration compared to other elements and the values are 1.667±0.006 and 1.883±0.523 mg/kg plant powder, respectively. Besides its significant biological importance, there are certain trace elements, which are toxic leading to several diseases and health complications[37]. A large number of researches have investigated the toxicity and side effects of these toxic elements. Among the heavy metals, Pb and Cd were toxic to human even at very low concentrations. According to the United States Pharmacopeia, Limits for Nutritional Supplement, the accepted standard toxicity levels of Pb and Cd for ingested products is 10.0 and 3.0 ppm, respectively. In the present study, the fruit pulp of *H. heteroclita* was found to contain very little concentration of Pb (0.534±0.107 mg/kg) and Cd (0.015±0.002 mg/kg), which is much less as per the toxicity level.

Free radicals, also known as reactive oxygen species (ROS) are atoms or group of atoms with unpaired electrons that are generated in the body during normal physiological conditions. ROS are harmful to the body leading to diseases such as cancer and diabetes[38]. Our body has an innate capacity of neutralizing those harmful ROS called antioxidant capacity or property. However, our innate antioxidant capacity to neutralize ROS is limited to certain concentration of free radicals and beyond that concentration our body fails to neutralize ROS. Plants act as a source of antioxidant molecules and can be used to boost our antioxidant capacity. In the present study, the total antioxidant activity of *H. heteroclita* was found to be 24.46±1.13 µg AAE/mg extract (Table 3). Similarly, DPPH, TBARS and FRAP assay of antioxidant activity revealed concentration-dependent activity of *H. heteroclita* (fig. 2). Increase in plant extract showed increased antioxidant activity with $R^2=0.9909$ and $R^2=0.9947$ for DPPH and TBARS, respectively. FRAP result also showed good relation between extract concentration and peroxidation activity ($R^2=0.8338$). The IC$_{50}$ values of DPPH and TBARS assay is found to be 1284.93±31.20 µg/ml and 431.16±36.37 µg/ml, respectively. Standard AA showed better antioxidant property with IC$_{50}$ values of 6.31±0.13 and 100.17±3.07 µg/ml for DPPH and TBARS, respectively. The presence of phytochemical contents, mainly TPC, TFC and AA showed strong...
correlation with the antioxidant activity of the plant (Table 4). All the phytochemical contents viz. TPC, TFC and AA showed good correlation (P<0.05) with antioxidant capacity (TAA, DPPH and TBARS) of the plant extracts. The high content of phytochemicals appeared to have been responsible for the high antioxidant capacity of the plant. In many reports, high lipid peroxidation activity possessed by plant extracts could be correlated with high phenolic content and number of hydroxyl group in the compounds[39]. Similar to the present investigation, a large number of reports also showed increasing trend of reducing power activity with increase of plant concentrations[40]. Therefore, the reducing capacity of the plant extracts may function as an indicator of potential antioxidant capacity of the plant.

The presence of phytochemicals such as phenolics, alkaloids, flavonoids, steroids and saponins in *H. heteroclita* provide a reason why the plant possessed biological activities that are of pharmacological significance. The presence of high phenolic, flavonoid compounds and vitamin C contents could be attributed to its pharmacological activity associated with free radical scavenging activity. Furthermore, evaluation of total antioxidant activity, DPPH, FRAP and TBARS also indicated the high potential of scavenging free radicals by the plant extract. The trace element content of *H. heteroclita* has also been found within the permissible limits from the studies. The present data would certainly help to ascertain the potency of the tested part of the plant for medicinal use and functional food and nutraceutical applications. Therefore, further investigations are needed for the isolation and identification of the active components of the plant and also to elucidate the mechanism of action responsible for the biological activity and antioxidant activities as well.

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**Conflict of interests:**

Authors declare no conflict of interests.

**Financial support and sponsorship:**

Nil.

**REFERENCES**


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**TABLE 4: PEARSON CORRELATION OF THE DIFFERENT *IN VITRO* ANTIOXIDANT ASSAYS OF *H. HETEROCILITA***

<table>
<thead>
<tr>
<th></th>
<th>AA</th>
<th>TPC</th>
<th>TFC</th>
<th>TAA</th>
<th>DPPH</th>
<th>TBARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TPC</td>
<td>0.986</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFC</td>
<td>0.990</td>
<td>1.000</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAA</td>
<td>0.997</td>
<td>0.969</td>
<td>0.975</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPPH</td>
<td>0.984</td>
<td>1.000</td>
<td>0.999</td>
<td>0.966</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TBARS</td>
<td>0.898</td>
<td>0.959</td>
<td>0.952</td>
<td>0.859</td>
<td>0.962</td>
<td>1</td>
</tr>
</tbody>
</table>


