STUDIES ON ANTIOXIDANT POTENTIAL OF TWO DIFFERENT SOLVENT EXTRACT FROM RAW AND HYDROTHERMAL PROCESSED SAMPLES OF Artocarpus altilis (Parkinson) Fosberg AND Colocasia esculenta (L) Schott

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ABSTRACT
Overproduction of free radicals or reactive oxygen species (ROS) contributes to oxidative stress, which leads to damage of proteins, DNA and lipids that is associated with chronic degenerative diseases, including cancer, coronary artery diseases, hypertension and diabetes etc. The human body has an elaborate antioxidant defence system. Antioxidants are manufactured within the body and can also be extracted from the food humans eat such as fruits, vegetables, seeds, nuts, meats and oil. Ironically the largest numbers of people suffering from micro nutrient malnutrition live in south Asia, a region with an incredible diversity of fruits and vegetables that are excellent sources of micronutrients. To overcome this challenge, the safest, nutritious and wholesome food for poor and underutilized populations is essential and resulted in the search for inexpensive and reliable alternative sources of protein of plant origin. Hence the present study is focused to evaluate the functional, nutritional, anti-nutritional, antioxidant and feed potentiality of raw and hydrotthermally processed samples of A. altilis and (Parkinson) Forsberg and C. esculenta (L) Schott. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Hence the research can contribute to the health benefits of the weaker society or to the unhealthy population of our country. Further the utilization prospectus of the A. altilis and C. esculenta could be exploited and advocated for wider consumption and conservation in rural vicinity.

Key Words: Antioxidants, Free radicals, Flavonoids, A. altilis, C. esculenta

INTRODUCTION
Plants usually contain natural antioxidants that can scavenge free radicals and those natural antioxidants have the capacity to improve food quality and can also act as nutraceuticals to cease free radical chain reactions in biological system. Biomedical research reveals that increase in the reactive oxygen species (ROS) results in the initiation and promotion of many major diseases. Thus to deal with the potential dangers of ROS in plants they have a number of antioxidant defences such as phytohormone release and activation of genes helps the plants to maintain low steady state levels of ROS in plants. One of the major ways to defeat the degenerative diseases in human is to develop body antioxidant status. This could be achieved by regular consumption of vegetables and fruits in our daily life. Thus in the present investigation the successive extraction of A. altilis and C. esculenta was screened for in vitro antioxidant properties using standard operating procedures. The earlier research findings have found the benefits which have been attributed to some of the phytochemical constituents, in particular to polyphenols. This has enforced the research in finding natural antioxidants in plants and vegetables that may be of utmost important in pathologies involving reactive oxygen species, as well as preservation of food substances against oxidation. It has been established that ROS can be both harmful and beneficial in biological systems depending on the environment. Natural antioxidants gained importance over synthetic antioxidants because of presumed safety, and its impending nutritional benefits and therapeutic...
effects. Among all the natural antioxidants, polyphenols gain significance because of their high redox potential which allows them to act as reducing agents, hydrogen donors and singlet oxygen quenchers. Moreover, polyphenols are profusely present in our diet. But the Excessive collection, reclaiming or clearing of natural environment, deforestation results in the extinction of such economically important plants which serves as the most important sources of polyphenols which we consume in our diet. A. altilis (Bread fruit) is the fruit of a tropical tree species in the mulberry family, Moraceae. Although native to the Malay Peninsula and Western Pacific islands, it is now been cultivated in the tropical regions including several African and Latin America countries. Bread fruit is a staple food in many tropical regions. It is very rich in starch, and before being eaten, it is roasted, baked, fried or boiled. And it is a versatile food and can be cooked and eaten at all stages of maturity, although it is most commonly harvested and consumed when mature, but still firm, and used as a starchy staple. Research on the efficacy of bread fruit extracts from various parts of the plant has shown promising results. The leaves are used to treat liver disease and fevers in Taiwan and an extract from the flowers was effective in treating ear edema. Bark extracts exhibited strong cytotoxic activities against leukaemia cells in tissue culture. Therefore the intake of fruit and vegetables are of significant importance in the human diet because they are rich sources of vitamins and minerals with lower calories, and they supply protein and fibers. Hence the study contributes significantly to food and income security of people engaged in its production and trade, particularly in developing countries. In addition, the present study can also strengthen the varietal biodiversity conservation in both remote villages and agro-ecosystems. Based on the indigenous knowledge system, the cost effective and more affordable processing techniques will be developed for the reduction of anti-nutrients and wider consumption of A. altilis in rural vicinity. And the other sample collected for the study C. esculenta which belongs to the family Araceae. It is grown for its edible corms as a staple food throughout subtropical and tropical regions of the world. The elephant's ear plant gets its name from the leaves, which are shaped like a large ear or shield. The plant reproduces mostly by means of rhizomes (tubers, corms) but it also produces "clusters of two to five fragrant inflorescences in the axils". Stem of this plant are used as vegetable in Indian traditional food system from many decades. Besides the stems, other parts of the plant, such as leaves and roots, have also been used in the traditional system of medicine. The leaves of the plant are reported to possess huge vitamin C content and the root is rich in starch and essential nutrient such as thiamine, riboflavin, niacin and oxalic acid. Mainly two pharmacologically active groups of compounds present in the C. leaf extracts are flavanoids and triterpinoids. Tarro corms provide healthy amounts of some important minerals like zinc, magnesium, copper, iron and manganese. In addition, the root has very good amounts of potassium that helps to regulate heart rate and blood pressure. Hence this plant is a promising source of nutrition and the conservation of such kind of plants is very important for the survival of a healthy generation and to ensure sustainable development in the future by increasing the utilization prospectus of the collected samples and it could be exploited and advocated for wider consumption and conservation in rural vicinity. Findings from the study can be used as baseline information to promote cultivation of the proposed plants in an extensive range. After processing only, rural people in India consume the bread fruit and tarro root in their diet. Thus, it is important to investigate the changes in processing and whether processing increases or decreases the antioxidant activity of the samples. Since free radicals have been implicated to be responsible for many metabolic disorders, this study is designed to further explore the antioxidant activities in this collected plant sample extracts in-vitro. Results from this preliminary study may provide a better understanding of the antioxidant properties of this plants for developing value-added foods and neutaceuticals as it gains more importance because in our present situation the new discoveries of drugs from medicinal plants is tremendous and vast field of scientific
exploration. But it should have a reverse pharmacological approach to develop cost-effective drugs from the knowledge provided by the traditional medical literatures which serves as a powerful search engine in the context of providing the lead in discovery and research of new drugs. The universal role of plants in the healing of diseases is exemplified by their employment in all the major systems of medicines. Moreover, the traditional knowledge about our significant indigenous plant species has reduced in the present generation influenced by urbanization. Indigenous plant species provide a variety of products like food, and medicines where the Indian subcontinent had been one of the rich emporia of 2500 plant species used in the indigenous treatment and food sources.

MATERIAL AND METHODS

Chemicals

Ferric chloride, 2, 2′-diphenyl-1-picrylhydrazyl (DPPH), potassium persulfate, 2,2 azinobis (3-ethylbenzo-thiozoline-6-sulfonic acid) disodium salt (ABTS), 6-hydroxy-2,5,7,8-tetramethylchroman 2-carboxylic acid (trolox), ferrous chloride, ammonium thiocyanate, hydrogen peroxide, ferrous ammonium sulfate, ethylene diamine tetra acetic acid (EDTA) disodium salt were obtained from Hi Media, Merck or Sigma. All other reagents used were of analytical grade.

Plant samples and processing

A. altilis green fruit and stem and rhizome of C. esculenta were collected from their natural vicinity at Palakkad district, Kerala, India during Dec 2013. The samples were divided into two portions. One portion was taken as raw and the other portion was taken for boiling. The samples were cut into pieces and boil for 100°C for 15 min in the ratio 1:10 (w/v). The remaining water after boiling was discarded and the samples were dried in room temperature. The raw and boiled samples were ground to fine powder and stored in screw capped bottles for further analysis.

Solvent extraction

Powdered samples of A. altilis and C. esculenta (each 15 g) were defatted by using petroleum ether in the ratio of 1:10 w/v with occasional shaking at room temperature for 24 h. Then the samples were filtered through Whatmann No.1 filter paper. Then the samples were air dried and extracted with 70% acetone and 80% methanol for all the samples in the ratio of 1:7 by occasional stirring at room temperature for 48 h and filtered through Whatmann No.1 filter paper. The residues were re-extracted with 70% acetone and 80% methanol in the ratio of 1:5 for another 24 h. The solvent extracts obtained were dried at 40 °C in an incubator (until sample getting a constant weight) and recovered with the respective solvents. The extract percentage recovery was calculated as equation,

\[
\text{Recovery} \% = \frac{(\text{Extract+container}(g) - (\text{Empty -container}(g))}{\text{Sample weight (g)}} \times 100
\]

Estimation of total phenolics and tannins

The total phenolic content was determined according to Folin-Ciocalteau method (FCM). FCM actually measures a sample’s reducing capacity and can be considered as another antioxidant (electron transfer) capacity assay. For the assay, aliquots (100 µL) of extracts were taken in test tubes and the volume was made up to 1 mL with distilled water. Then 0.5 mL of Folin-Ciocalteau phenol reagent (1:1 with water) and 2.5 mL of sodium carbonate solution (20 %) were added sequentially in each tube. Soon after vortexing the reaction mixture, the test tubes were placed in dark for 40 min and the absorbance was recorded at 725 nm against the reagent blank. The analysis was performed in triplicate and the results were expressed as the tannic acid equivalents (TAE). Tannins in the extracts were estimated after treatment with polyvinyl polypyrrolidone (PVPP). One hundred milligrams of PVPP was weighed in a 100 mm × 12 mm test tube and to this 1.0 mL of distilled water and then 1.0 mL of tannin containing phenolic extract were added. The content was vortexed and kept in the test tube at 4°C for 4 h. Then the sample was centrifuged (3000g for 10 min at room temperature) and the supernatant was collected. This supernatant has only simple phenolics other than tannins (the tannins would have been precipitated along with the PVPP). The phenol content of the supernatant was measured, as mentioned above and expressed as the content of
non-tannin phenolics on a dry matter basis. From the above results, the tannin content of the sample was calculated as follows:
\[
\text{Tannin (\%) = \frac{\text{Total phenolics (\%) - Non-tannin phenolics (\%)}}{\text{Total phenolics (\%)}} \times 100}
\]

**Total flavonoids**

The total flavonoid content was measured by a spectrophotometric assay outlined by Siddhuraju and Becker. 0.1 mL aliquot of standard solution of Rutin at different concentrations (0-100 mg/L, external calibration with n = 6 concentrations) or sample was added to 10 mL volumetric flasks containing 4 mL water. At the onset of the experiment, 0.3 mL of 5% NaNO₂ was added to the flask. After 5 min, 3 mL of 10% AlCl₃ was added. At 6 min, 2 mL of 1M NaOH was added to the mixture. Immediately, the solution was diluted to a final volume of 10 mL with water and mixed thoroughly. The absorbance of the mixture was determined at 510 nm versus the reagent blank.

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

The antioxidant capacities of phenolic extracts of raw and processed *A. altilis* and *C. esculenta*. FRAP reagent (900 μL), prepared freshly and incubated at 37°C, was mixed with 90 μL of distilled water and 30 μL of test sample, or methanol (for the reagent blank). The test samples and reagent blank were incubated at 37°C for 30 min in a water bath. The FRAP reagent contained 2.5 mL of 20 mmol/L TPTZ solution in 40 mmol/L HCl plus 2.5 mL of 20 mmol/L FeCl₃·6H₂O and 25 mL of 0.3 mmol/L acetate buffer, pH 3.6. At the end of incubation the absorbance readings were taken immediately at 593 nm using a Spectrophotometer. Methanolic solutions of known Fe (II) concentration ranging from 100 to 2000 μmol/L (FeSO₄·7H₂O) were used for plotting the calibration curve. The parameter Equivalent Concentration (EC₁) was defined as the concentration of antioxidant having a ferric-TPTZ reducing ability equivalent to that of 1 mmol/L FeSO₄·7H₂O. EC₁ was calculated as the concentration of antioxidant giving an absorbance increase in the FRAP assay equivalent to the theoretical absorbance value of a 1 mmol/L concentration of Fe (II) solution determined using the corresponding regression equation.

**Table 1 : Total Phenolics, Tannins and Flavanoid content of *A. altilis* and *C. esculenta***

<table>
<thead>
<tr>
<th>Sample</th>
<th>Total Phenolics (mg of TAE/g extract)</th>
<th>Tannins (mg of TAE/g extract)</th>
<th>Flavanoid (mg of RUE/g extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AaRA</td>
<td>93.21±0.72</td>
<td>24.71±0.51</td>
<td>43.33±3.52</td>
</tr>
<tr>
<td>AaBA</td>
<td>92.56±0.72</td>
<td>26.41±0.17</td>
<td>48.22±2.77</td>
</tr>
<tr>
<td>AaRM</td>
<td>111.70±2.56</td>
<td>27.28±0.17</td>
<td>45.66±1.09</td>
</tr>
<tr>
<td>AaBM</td>
<td>101.69±1.92</td>
<td>32.56±0.35</td>
<td>44.44±2.00</td>
</tr>
<tr>
<td>CeSRA</td>
<td>73.54±1.97</td>
<td>23.45±0.14</td>
<td>49.33±2.72</td>
</tr>
<tr>
<td>CeSBA</td>
<td>68.44±0.77</td>
<td>27.09±0.38</td>
<td>49.77±2.69</td>
</tr>
<tr>
<td>CeSRM</td>
<td>57.78±1.60</td>
<td>18.41±0.22</td>
<td>41.11±3.97</td>
</tr>
<tr>
<td>CeSBM</td>
<td>67.85±1.71</td>
<td>22.56±0.33</td>
<td>48.33±2.02</td>
</tr>
<tr>
<td>CeRRA</td>
<td>102.10±2.12</td>
<td>19.70±0.21</td>
<td>45.66±2.18</td>
</tr>
<tr>
<td>CeRBM</td>
<td>63.41±2.66</td>
<td>24.91±0.42</td>
<td>44.66±3.17</td>
</tr>
<tr>
<td>CeRBA</td>
<td>85.33±0.89</td>
<td>25.82±0.33</td>
<td>45.66±2.02</td>
</tr>
<tr>
<td>CeRRM</td>
<td>55.64±2.23</td>
<td>25.82±0.33</td>
<td>47.55±3.00</td>
</tr>
</tbody>
</table>
Metal chelating activity

The extracts (100 µL) were added to a solution of 2 mM FeCl₃ (0.05 mL). The reaction was initiated by the addition of 5 mM/L ferrozine (0.2 mL) and the mixture was shaken vigorously and left standing at room temperature for 10 min. Absorbance of the solution was then measured spectrophotometrically at 562 nm. The results were expressed as mg EDTA equivalent/g extract. Linearity range of the calibration curve was 0.5-2.5 µg.³

Table 2: DPPH and ABTS radical scavenging activity and FRAP and metal chelating activity of raw and processed tubers of A. altilis and C. esculenta

<table>
<thead>
<tr>
<th>Sample</th>
<th>DPPH Radical scavenging activity</th>
<th>ABTS Radical scavenging activity</th>
<th>FRAP(mmolFe(II)/g extract)</th>
<th>Metal chelating activity(mgEDTA/g extract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AaRA</td>
<td>20608.27±132.46</td>
<td>28566.98±593.06</td>
<td>6414.94±174.44</td>
<td>0.70±0.01</td>
</tr>
<tr>
<td>AaBA</td>
<td>14603.41±146.22</td>
<td>28276.86±749.48</td>
<td>2379.72±150.40</td>
<td>0.56±0.02</td>
</tr>
<tr>
<td>AaRM</td>
<td>13965.94±138.75</td>
<td>28235.41±749.48</td>
<td>6643.35±181.32</td>
<td>0.83±0.02</td>
</tr>
<tr>
<td>AaBM</td>
<td>19654.50±58.99</td>
<td>28090.35±725.90</td>
<td>9255.77±271.735</td>
<td>0.74±0.01</td>
</tr>
<tr>
<td>CeSRA</td>
<td>12948.91±200.69</td>
<td>27572.27±6041.66</td>
<td>10002.86±102.94</td>
<td>0.40±0.01</td>
</tr>
<tr>
<td>CeSBA</td>
<td>11927.01±119.49</td>
<td>24111.49±458.26</td>
<td>2355.93±65.93</td>
<td>0.84±0.03</td>
</tr>
<tr>
<td>CeSRM</td>
<td>10963.50±139.26</td>
<td>18661.27±1598.78</td>
<td>6405.42±65.41</td>
<td>1.59±0.02</td>
</tr>
<tr>
<td>CeSBM</td>
<td>13138.69±176.99</td>
<td>217699.76±258.83</td>
<td>7723.53±200.02</td>
<td>0.86±0.02</td>
</tr>
<tr>
<td>CeRRA</td>
<td>11055.96±124.15</td>
<td>28753.49±469.37</td>
<td>3212.46±101.27</td>
<td>0.85±0.01</td>
</tr>
<tr>
<td>CeRBM</td>
<td>11299.27±133.79</td>
<td>26619.00±319.03</td>
<td>13709.73±134.92</td>
<td>0.82±0.02</td>
</tr>
<tr>
<td>CeRBA</td>
<td>19868.61±139.26</td>
<td>28173.24±715.17</td>
<td>3136.33±102.94</td>
<td>0.83±0.01</td>
</tr>
<tr>
<td>CeRRM</td>
<td>16394.16±153.8</td>
<td>28442.64±657.94</td>
<td>6905.06±181.32</td>
<td>0.72±0.02</td>
</tr>
</tbody>
</table>

Stable free radical scavenging activity using DPPH method

The radical scavenging activity of sample extracts was measured using DPPH radical by the method of Brand-Williams et al. with some modifications. Extract of 0.1 mL prepared in methanol was mixed with 3.9 mL of DPPH (6×10⁻³ mol/L methanol) and incubated in dark for 30 min. Absorbance was recorded at 515 nm and the results were expressed as mmol trolox equivalents/g extract.

Total antioxidant activity assay by scavenging of (ABTS⁻) radical cation

ABTS was dissolved in water to a 7 mM concentration. ABTS radical cation (ABTS) was produced by reacting ABTS stock solution with 2.45 mM potassium persulfate (final concentration) and allowing the mixture to stand in the dark at temperature for 12-16 h before use. Prior to assay, the solution was diluted in ethanol (about 1:89 v/v) and equilibrated to 30°C to give an absorbance at 734 nm of 0.700± 0.02 in a 1cm cuvette. The stock solution of the sample extracts in ethanol was diluted such that, after introduction of a 10 µl aliquot of each dilution into the assay, they produced between 20-80 % inhibition of the blank absorbance. After the addition of 1 mL of diluted ABTS solution to 10 µl of samples or Trolox standards (final concentration 0-15 µM) in ethanol OD (optical density) was taken at 30°C exactly 30 min after the initial mixing. Appropriate solvent blanks were also run in each assay. Triplicate determinations were made at each dilution of standard, and the percentage inhibition of the blank absorbance at 734 nm was plotted as a function of Trolox concentration. The unit of total antioxidant activity (TAA) is defined as 1 the concentration of Trolox having equivalent
antioxidant activity expressed as μmol/g sample extracts using the calibration curve of trolox. Linearity range of the calibration curve was 0.25-1.25 mmol/L. The total antioxidant activity of ASC and BHA were also measured by ABTS method for comparison.

**Nitric oxide scavenging activity assay**

Nitric oxide generated from sodium nitroprusside (SNP) was measured by the Griess reaction. Nitric oxide interacts with oxygen to produce nitrite ions that can be observed by Griess reagent. Scavengers of nitric oxide compete with oxygen leading to reduced production of nitric oxide.\(^1\) Various concentrations (500µg) of sample extracts and sodium nitroprusside (SNP, 5 mM final concentration) in phosphate buffer saline, pH 7.4, in a final volume of 1 mL, were incubated at 25°C for 150 min. A control experiment without samples but with equivalent amount of vehicles was conducted in an identical manner of the sample. After incubation, the reaction mixtures were mixed with Griess reagent (1% sulfanilamide and 0.1% naphthylethylene diamine dihydrochloride in 5% H2PO4). The absorbance of the chromophore formed during diazotization of nitrite with sulfanilamide and subsequent coupling with naphthylethylene diamine was measured at 540 nm. The total antioxidant activity of ASC (500 µg) and QUE (500 µg) were also measured by nitric oxide scavenging method for comparison. The % Nitric oxide scavenging activity was calculated by the following equation,

\[
\text{% Nitric oxide scavenging activity} = \left( \frac{\text{Control OD-Sample OD}}{\text{Control OD}} \right) \times 100
\]

**Statistical analysis**

The data were subjected to one way analysis of variance (ANOVA), and the significance of the difference between means were determined by Duncan’s multiple-range test (P < 0.05) using SPSS (Version 13.0, SPSS Inc., Wacker Drive, Chicago, USA). Values expressed are means of triplicate determinations ± standard deviation. Pearson's correlation test was conducted to determine the linear correlations among variables.

**RESULTS AND DISCUSSION**

**Total phenolics and tannins**

Phenolic compounds are secondary metabolites that are derivatives of the pentose phosphate shikimate and phenyl proponoid pathways in plants. Tannins or polymeric polyphenols are also potent antioxidant than simple monomeric phenolics and thus may be important dietary antioxidants revealed by Hagerman et al. So, it is reasonable to determine the phenolics and tannins in selected plant extracts. The total phenolic and tannin content of the two different solvent extracts of raw and processed A. altillis (fruit) and C. esculenta (stem and rhizome) were determined using Folin Ciocalteu’s reagent and the results are presented in Table 1. In the present study phenolic content of methanol extracts of A. altillis ranged from 101.69-111.70 mg TAE /g extract and the acetone extract of A. altillis ranged from 92.56-93.21 mg TAE / g extract. The phenolic content of the A. altillis raw samples ranged from 93.21-111.70 mg TAE / g extract and processed samples ranged from 92.56-101.61 mg TAE / g extract and the raw samples showed the higher phenolic content than the processed samples. And in the results the phenolic content of the acetone extract was found to be higher than the methanol extract. Total phenolics in the C. esculenta raw samples were ranged from 55.64-102.10 mg TAE / g extract and the processed samples ranged from 63.41-85.33 mg TAE / g extract. Mesh et al. reported that the phenolic content of the acetone extracts of Jack fruit pulp ranged from 0.18±0.012 mg GAE / g and the methanol extracts of Jack fruit pulp ranged from 0.21±0.012 mg GAE / g and these results when compared to our study showed lower phenolic value than our samples. The phenolic content of the tubers such as tapioca (137.55±6.04 gallic acid equivalents mg / 100 g) C. antiquorum (81.59±21.03 equivalents mg / 100 g) and radish (66.73±18.46 gallic acid equivalents mg / 100 g) shows the similar level of phenolics when compared with the extracts of C. esculenta observed by Sreeramulu et al. The tannin content of the methanol extract of A. altillis was 27.28-32.56 mg TAE / g extract and the acetone extract was 24.711-26.41 mg TAE / g extract. The tannin content of the processed samples was higher than the raw samples and this might be due to the enhanced extractability of tannins. The tannin content of the raw samples showed higher tannin content than the boiled samples and such poor extractability of tannins could be due to the formation of insoluble complexes with structural polysaccharides.

**Flavonoids**

Phenolic acid and Flavanoids have been reported to be the main phytochemicals responsible for the
antioxidant capacity of fruit and vegetables. The processed sample registered higher amount of total flavanoid content than the raw samples. The flavanoid content of the acetone extracts of A. heterophyllus (2.21 ± 0.02 mg QE/g) was lower than the A. altillis extracts. In the present study both the raw and processed extract of C. esculenta stem showed higher flavanoid content than the rhizome extract and the processed samples showed higher amount of total flavanoid content than the raw samples. The flavanoid content of 20.058 ± 0.148 mg / QE reported lower than that of our reports in C. esculenta.

Free radical scavenging activity on DPPH
The values exhibits that the DPPH radical scavenging activity of acetone extracts was higher than the methanol extracts for both the samples and the raw samples showed higher DPPH value than the processed samples. The order of activity of A. altillis extracts were decreased as follows, AaRA>AaBM>AaBA>AaRM. In the case of C. esculenta the order of activity of extracts decreased in the following order CeRBA>CeRRM>CeSBA>CeSRA>CeSA>CeRBM>CeSRA>CeSRM.

Antioxidant activity by ABTS assay
ABTS radical scavenging activity of acetone extracts of A. altillis was higher than (28276.86-28566.98 mmol TE / g extract) the methanol extracts (28090.35-28235.41 mmol TE / g extract) and the scavenging activity of C. esculenta for acetone extract was 24111.49-28753.49 mmol TE / g extract ) and the methanol extract was 18861.27-28442.64 mmol TE / g extract ). In both the samples the acetone extracts showed higher radical scavenging activity than the methanol extracts.

Ferric reducing antioxidant power
Reducing power is a measure of ability of the extracts to reduce Fe³⁺ to Fe²⁺. Substances which have reduction potential reacts with potassium ferricyanide to form potassium ferrocyanide which then react with ferric chloride to form ferric ferrous complex that has become one of the antioxidant capacity indicators of medicinal plant as it may accord with overall antioxidant activity. This is because antioxidants are strong reducing agents and this is principally because of the redox properties of their hydroxyl groups and the structural relationships of any parts of their structure. The reducing power, shown by the ability of the extracts to reduce Fe³⁺ to Fe²⁺ was determined and the results were presented in Table 2.

Table 2. Acetone extract of A. altillis was from 2379.72-6414.94 mmol Fe (II) / g extract and for the methanol extracts was from 6643.35-9255.77 mmol Fe (II)/g extract. The reducing ability of the methanol extracts were higher than the acetone extracts.

Metal chelating activity
The chelating effect for all the extracts are evaluated and denoted in Table 2. The activity was in the range of 0.74-0.83 mg EDTA equivalents / g extract for methanol extracts and 0.56-0.70 mg EDTA equivalents / g extract for acetone extracts of the sample A. altillis .The metal chelating activity of A. altillis are decreased in the order AaRM> AaBM> AaRA> AaBA and for C. esculenta the activity was ranged from 0.72-1.59 mg EDTA equivalents / g extract for methanol extracts and 0.40-0.85 mg EDTA equivalents / g extract for acetone extracts and their activities are decreased in the order CeSRM>CeSBA>CeSRA>CeSA>CeRBM>CeRRM>CeSRM. Chelating agents, which form σ bonds with a metal , are effective as secondary antioxidants because they reduce the redox potential thereby stabilizing the oxidized form of the metal ion.

Nitric oxide radical scavenging activity
This scavenging effect against nitric oxide radical is also a wanted property of an antioxidant molecule. Hence this was measured and the results were shown in Fig. 1. From the result it was found that the activities of samples were ranging from 34.11-56.79% and 44.44-55.76% for the methanol and acetone extracts for the A. altillis sample respectively.

The nitric oxide radical scavenging activity in these samples was higher when compared to the other studies. Each value is expressed as mean ± standard deviation (n=3). AaRA- A. altillis raw acetone extract; AaBA- A.altillis boiled acetone extract; AaRM-A.altillis raw methanol extract; AaBM- A.altillis boiled methanol extract;CeSRA- C. esculenta stem raw acetone extract; CeSBA- C. esculenta stem boiled acetone extract; CeSRM- C. esculenta stem raw methanol extract; CeSMB- C. esculenta stem boiled methanol extract;CeRRA- C. esculenta rhizome raw extract; CeRBA- C. esculenta rhizome boiled acetone extract; CeRRM- C. esculenta rhizome raw methanol extract; CeRBM- C. esculenta rhizome boiled methanol extract; Asc- Ascorbic acid; Que-Quercitin.
CONCLUSION
Reduced dietary diversity has serious effects on the nutrition and health of rural and urban populations and deprives rural farmers of opportunity to generate income from their produce, whereas dietary diversification is widely accepted as a cost-effective and sustainable way of improving malnutrition. Neglected and underutilized food resources constitute the bedrock of the diversity in traditional and indigenous food systems of developing country communities. Traditional and indigenous foods are less deleterious to the environment and address cultural needs and preserve the cultural heritage of local communities. Underutilized minor crop species are still a major source of nutrition for many indigenous communities. Thus, food and nutrition security of poor and marginal rural people is possible through the conservation and promotion of indigenous plant resources such as *C. esculenta* and *A. altillis* that contain high nutrition. *C. esculenta* is a very hearty succulent herb. Chemically the plant contains various biologically active components like vitamins, flavanoids, titerpinoids, glycosides, mineral, micronutrients and carotenoids. The plant has been studied for various pharmacological activities like antifungal, anticancer, antibacterial antioxidant, hypolipidemic, hepatoprotective, hypoglycaemic, and antihyperlipidemic activity. The extracts from and the other sample *A. altillis* were found to possess strong antioxidant activity and these bread fruit is a rich source of phytochemicals including phenolic compounds and offers opportunities for development of value-added products from breadfruit such as nutraceuticals and food applications to enhance health benefits. Hence the present study evaluated antioxidant activity of aqueous acetone and methanol extracts of raw and processed extracts of *C. esculenta* and *A. altillis* and the present study showed raw samples of both extracts exhibited the best free radical scavenging activity and antioxidant potential and it could be noticeable for better utilization as natural antioxidants in various food and pharmaceutical industries.

![Fig. 1](image-url): Nitric oxide radical scavenging activity of *A. altillis* and *C. esculenta* samples

REFERENCES


