The present study was conducted to evaluate the phenolics, antioxidant and antimicrobial activities of leaf and seed extracts from an edible herb namely *Amaranthus viridis* L. The extract yields of active components, produced using pure and aqueous methanol, from the leaves and seeds ranged from 5.4 to 6.0 and 2.4 to 3.7%, respectively. The extracts contained appreciable levels of total phenolic contents (1.03 to 3.64 GAE, g/100 g) and total flavonoid contents (18.4 – 5.42 QE, g/100 g) and also exhibited good 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity as revealed by IC₅₀ (14.25 - 83.43 µg/ml). Besides, the tested extracts showed considerable antimicrobial activity against selected bacterial and fungal strains with minimum inhibitory concentrations (MIC) ranging from 179-645 µg/ml. Of the parts tested, the seed extracts exhibited superior antioxidant and antimicrobial activity. It was concluded that *A. viridis* leaf and seed can be explored as a potential source for isolation of antioxidant and antimicrobial agents for uses in functional food and pharmaceuticals.

Key words: *Amaranthus viridis*, phytochemical constituents, minimum inhibitory concentrations (MIC), total phenolics, total flavonoids, 1,1-diphenyl-2-picrylhydrazyl (DPPH), radical scavengers.

INTRODUCTION

*Amaranthus viridis* L. (Amaranthaceae), commonly known as “Chowlai”, is a fast growing herb mainly cultivated in Asia, Africa and Latin America (Amin et al., 2006). Being resistant to drought, hot climate and pests, and with little requirements for its cultivation, this pseudo-cereal has attracted much attention as an important food commodity (Sexna et al., 2007). In the last decade, the use of amaranth has expanded not only in the common diet, but also in diet of people with celiac disease or allergies to typical cereals (Berti et al., 2005). Reactive oxygen species (ROS) and reactive nitrogen species produced as a result of oxidation have been shown to be linked with different degenerative disorders such as aging, inflammation, cancer, cardiovascular complications, and osteoporosis (Wilcox, 2004). Interest in search for new natural antioxidants has grown over the past few years because of their preventive role in protecting from oxidative-stress related chronic diseases (Halovrson et al., 2002).

Existence of microorganisms causes food spoilage and results in deterioration of the quality and quantity of processed food products. Some plant-based biologically active compounds isolated from herbs have been explored for the growth inhibition of pathogenic microbes because of their antimicrobial potential (Abubakar et al., 2008). The medicinal value and multiple biological functionalities of several plants are defined by their phytochemical constituents (Fallah et al., 2005). Many herbal species being a promising source of bioactive compounds such as phenolics, anthocyanins, flavonoids, and carotenoids, are usually used to impart flavor and enhance the shelf-life of dishes and processed food products, recently reported work was (Nisar et al., 2010a, b, 2011; Qayum et al., 2012; Zia-Ul-Haq et al., 2008, 2011a, b, 2012). Due to their high antioxidant potency, the consumption of many such plants species is recommended (Ozsoy et al., 2009). Antioxidant
Properties of green leafy vegetables and herbs including different amaranth species have been preliminarily studied (Ozbucak et al., 2007).

The main aim of the present study was to evaluate the phenolic compounds, antioxidant and antimicrobial activities of pure and aqueous methanol extracted components from leaves and seeds of locally grown *Amaranthus viridis* plants to explore their potential pharmaceutical and/or functional food uses.

**MATERIALS AND METHODS**

**Collection and pretreatment of plant material**

The leaves and seeds of fully matured *A. viridis* L. were collected during June to July 2009, from the local fields of Faisalabad, Pakistan, and identified by the Department of Botany, GC University Faisalabad, Pakistan. Collected specimens were dried at room temperature and stored in polyethylene bags at 4°C.

**Chemical and reagents**

1,1-diphenyl-2-picrylhydrazyl (DPPH), gallic acid, Folin-Ciocalteu reagent, sodium nitrite, butylated hydroxytoluene (BHT) were obtained from Sigma Chemical Co (St. Louis, USA) and anhydrous sodium carbonate, methanol and ethanol used were obtained from Merck (Darmstadt, Germany). All culture media antibiotic, discs and sterile solution of 10% (v/v) DM SO in water were purchased from Oxoid (Hampshire, UK).

**Preparation of *A. viridis* extracts**

Ground (80 mesh) leaf and seed samples (100 g each) were extracted separately with 1000 ml absolute methanol and 80% methanol (80:20, methanol: water, v/v) using an orbital shaker (Gallenkamp, UK) for 12 h at room temperature. The extracts were separated from solids by filtering through Whatman No. 1 filter paper. The residues were extracted thrice and the extracts were collected. The solvent was removed under vacuum at 45°C, using a rotary vacuum evaporator (N-N Series, Eyela, Rikakikai Co. Ltd. Tokyo, Japan) and stored at 4°C till further analysis.

**Phytochemical screening**

The methanol extracts of the tested plant material were screened for the presence of various phytoconstituents such as phlobatannins, tannins, alkaloids, terpenoids, glycosides, flavonoids, and phenolic compounds (Abubakar et al., 2008).

**Antioxidant activity**

**Determination of total phenolic contents (TPC)**

Total phenolic contents (TPC) were determined using the Folin-Ciocalteu reagent method and gallic acid was used as gallic acid equivalent (GAE) (Amin et al., 2006).

**Determination of total flavonoid contents (TFC)**

The total flavonoid contents (TFC) in the leaf and seed extracts were determined following the modified procedure of Edeoga et al. (2005), and quercetin was used as standard as quercetin equivalent (QE).

**DPPH radical scavenging assay**

1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical assay was carried out spectrophotometrically (Miliauskas et al., 2004). The percent inhibition was calculated as:

\[
I(\%) = 100 \times \left(\frac{A_{\text{blank}} - A_{\text{sample}}}{A_{\text{blank}}}\right)
\]

Where \(A_{\text{blank}}\) is absorbance of the control reaction (containing all reagents except the test sample), and \(A_{\text{sample}}\) is the absorbance of test samples. Extract concentrations providing 50% inhibition (IC\(_{50}\)) values were calculated from the plot of percentage scavenging versus extracts concentration.

**Antimicrobial activity**

**Microbial strains**

The *A. viridis* leaf and seed extracts were individually tested against a panel of microorganisms (locally isolated), including two bacteria, *Staphylococcus aureus* and *Escherichia coli*, and two pathogenic fungi, *Fusarium solani* and *Rhizopus oligosporus*. The selected strains have strong pathogenic activities against plant and animals that lead to a significant loss of lives and food. The pure bacterial and fungal strains were obtained from the Bioassay section, Protein Molecular Biochemistry laboratory, Department of Chemistry and Biochemistry, University of Agriculture Faisalabad, Pakistan. The bacterial strains were cultured at 37°C overnight, while fungal strains were cultured overnight at 28°C in an incubator (Memmert, Germany).

**Disc diffusion method**

The antimicrobial activity of the leaf and seed extracts was determined by using disc diffusion method (CLSI, 2007). The discs (6 mm in diameter) were impregnated with 20 µg/ml sample extracts (20 µg/disc) and placed on inoculated agar. Rifampicin (20 µg/disc) (Oxoid) and fulconazole (20 µg/disc) (Oxoid) were used as positive reference for bacteria and fungi, respectively. Antimicrobial activity was evaluated by measuring the inhibition zones (in mm) by zone reader.

**Minimum inhibitory concentration (MIC) assay for determination of antimicrobial activity**

Incubator at 35 and 37°C; pipettes of various sizes (Gilson); sterile tips, 100, 200, 500 and 1000 µL; 5 ml multi-channel pipette; centrifuge tubes; vortex mixer; centrifuge (Fisons); Petri-dishes, sterile universal bottles; UV-spectrophotometer (Shimadzu) and sterile resazurin tablets (BDH Laboratory Supplies) were used. Isonosentist medium was used throughout this assay, as it is pH buffered. Although the use of Mueller Hinton medium was recommended for susceptibility testing (NCCLS, 2000), the isosentist medium had comparable results for most of the tested bacterial strains.

**Use of standardized bacterial colony numbers**

The method wherein turbidity is compared to McFarland standards...
Preparation of microbial culture

Using aseptic techniques, a single colony was transferred into a 100 ml bottle of isosensitest broth capped and placed in incubator overnight at 35°C. After 12 to 18 h of incubation, using aseptic preparation and the aid of a centrifuge, clean samples of bacteria and fungi were prepared. The broth was spun down using a centrifuge at 4000 rpm for 5 min with appropriate aseptic precautions. The supernatant was discarded into an appropriately labeled contaminated waste beaker. The pellet was re-suspended using 20 ml of sterile normal saline and centrifuged again at 4000 rpm for 5 min. This step was repeated until the supernatant was clear. The pellet was then suspended in 20 ml of sterile normal saline and was labeled as Bs. The optical density of the Bs was recorded at 500 nm, and serial dilutions were carried out with appropriate aseptic techniques until the optical density was in the range of 0.5 to 1.0. The actual number of colony forming units was calculated from the viability graph. The dilution factor needed was recorded at 500 nm, and serial dilutions were carried out with appropriate concentrations of 5 x 10^6 CFU/ml.

Preparation of resazurin solution

The resazurin solution was prepared by dissolving a 270 mg tablet in 40 ml of sterile distilled water. A vortex mixer was used to dissolve tablet and homogenous solution formation.

Preparation of the plates

Plates were prepared under aseptic conditions. A sterile 96 well plate was labeled. A volume of 100 µL of test material in 10% (v/v) dimethylsulphoxide (DMSO)/sterile water (10 mg/ml for crude extracts) was pipetted into the first row of the plate. To all other wells, 50 µL of nutrient broth or normal saline was added. Serial dilutions were performed using a multichannel pipette. Tips were discarded after use such that each well had 50 µL of the test material in serially descending concentrations. To each well, 10 µL of resazurin indicator solution was added. Furthermore, using a pipette, 30 µL of 3.3 x strength isosensitised broths was added to each well to ensure that the final volume was single strength of the nutrient broth. Finally, 10 µL of bacterial suspension (5 x 10^6 CFU/ml) was added to each well to achieve a concentration of 5 x 10^5 CFU/ml. Each plate was wrapped loosely with cling film to ensure that bacteria did not become dehydrated. Each plate had a set of controls: a column with a broad-spectrum antibiotic as positive control (usually ciprofloxacin in serial dilution), a column with all solutions with the exception of the test compound, and a column with all solutions with the exception of the bacterial solution adding 10 µL of nutrient broth instead. The plates were prepared in triplicate, and placed in an incubator set at 37°C for 18 to 24 h. The color change was then assessed visually. Any color change from purple to pink or colorless was recorded as positive. The lowest concentration at which color change occurred was taken as the MIC value. The average of three values was calculated and that was the MIC for the test material and microbial strain.

Statistical analysis

Values are given as means ± standard deviation (SD) of each measurement. Where appropriate, the data were tested by one-way ANOVA using Minitab 15. Pearson correlation coefficients and p-values were used to show correlations and their significance. Differences of P<0.05 were considered significant (Steel et al., 1997).

RESULTS AND DISCUSSION

Extract yields

Yields (g/100 g) of A. viridis leaf and seed extracts produced using different extraction solvents are given in Table 1. Maximum extract yields of antioxidant components from leaves and seed were obtained with 80% methanol (6.0 g/100 g) and 100% methanol (3.7 g/100 g), respectively. The present results demonstrated a significant (P<0.05) variations for the seed extract yields, but non-significant (P>0.05) for the leaves extract yields between the solvents used. The present extraction yields were lower than those reported by Ozsoy et al. (2009) in water, methanol and ethyl-acetate extracts of Amaranthus species (13.09 to 20.46 g/100 g). Kyung et al. (2006) also reported the strong antioxidant and antimicrobial activity of Amaranthus cruentus in diabetic rat.

Phytochemical constituents

In plants, the secondary metabolites function to attract beneficial and repel harmful organisms, serve as phytoprotectants and respond to environmental changes. In humans, however, the compounds have beneficial effects including antioxidant, anti-inflammatory, modulation of detoxification enzymes, stimulation of the immune system, modulation of steroid metabolism and antibacterial and antiviral effects (Lipkin et al., 2004). Table 2 shows the qualitative data for the presence of different phytochemicals in leaves and seeds of A. viridis. The results from the current study indicate that A. viridis leaves and seed extracts contained varied types of pharmacologically active compounds with antimicrobial potential. The commonly identified components in this species included flavonoids, cyanogenic glycoside, saponins, tannin, and phlobatannins. The results, especially for alkaloids, indicate levels comparatively similar to many medicinal plants (Elizbith et al., 1999; Okwu and Josiah, 2006), thus supporting the medicinal uses of this species.

Antioxidant activity

DPPH radical scavenging assay

We investigated DPPH free radical scavenging activity of A. viridis leaves and seeds extracts produced through
Table 1. Percentage yield extracts from leaves and seeds of *Amaranthus viridis*.

<table>
<thead>
<tr>
<th>Plant used</th>
<th>Extract</th>
<th>Percent yield (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>100% Methanol</td>
<td>5.4 ± 0.13&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>6.0 ± 0.14&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seeds</td>
<td>100% Methanol</td>
<td>3.7 ± 0.11&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>2.4 ± 0.04&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are mean ± SD of three samples analyzed individually in triplicate. Different letters in superscript indicate significant and non-significant differences with solvents.

Table 2. Phytochemical constituents of leaf and seed extract of *Amaranthus viridis*.

<table>
<thead>
<tr>
<th>Phytochemical constituent</th>
<th><em>Amaranthus viridis</em></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leave</td>
<td>Seed</td>
</tr>
<tr>
<td>Tannins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Phlobatannins</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Saponins</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Terpenoids</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

<sup>+</sup> Represents presence of the phytoconstituents; represents absence of the phytoconstituents.

Table 3. Antioxidant activity of *Amaranthus viridis* leaf and seed methanolic extracts.

<table>
<thead>
<tr>
<th>Plant used</th>
<th>Extracts</th>
<th>DPPH, IC&lt;sub&gt;50&lt;/sub&gt; (µg/ml)</th>
<th>TP contents*</th>
<th>TF contents**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>100% Methanol</td>
<td>14.25 ± 0.712&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.03 ± 0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.78 ± 0.20&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>83.43 ± 3.84&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.89 ± 0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.4 ± 0.30&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seeds</td>
<td>100% Methanol</td>
<td>46.50 ± 2.97&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.64 ± 0.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.42 ± 0.20&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>75.91 ± 3.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.20 ± 0.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.51 ± 0.07&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are mean ± SD of samples analyzed in triplicate. *, Total phenolic contents in gallic acid equivalent; **, Total flavonoid contents in quercetin equivalent.

extraction by pure and aqueous methanol. The free radical scavenging capacity increased with increasing extracts concentrations. The leaves and seed extracts showed good hydrogen-donating ability in the presence of DPPH stable radicals (Table 3), with IC<sub>50</sub> (the extract concentration providing 50% inhibition) values ranging from 14.25 – 83.43 and 46.50 – 75.91 µg/ml, respectively. When compared with the synthetic antioxidant BHT (15.7 µg/mL), the tested extracts offered slightly lower activity except 100% methanol leaf extract (14.25 µg/ml).

These results were consistent with previous observation that *Amaranthus* varieties contained radical scavenging agents that could directly react with and quench stable DPPH radicals (Oboh, 2005). The ability of an *Amaranthus paniculatus* extracts to act as a free radical scavenger or hydrogen donor has also been reported previously (Amin et al., 2006). The betalians from plants in the family Amaranthaceae exhibit strong antiradical activity, with IC<sub>50</sub> values ranging from 3.4 to 8.4 µM, and representing a new class of dietary antioxidants (Cai et al., 2005). These results showed that the methanol leaf extract contained strongest DPPH free radical scavenging compounds; the efficacy of those was quite comparable with the positive control BHT (15.7 µg/ml).

**Total phenolic and total flavonoid contents**

The total phenolic content (TPC) and total flavonoid content (TFC) of *A. viridis* leaf and seed extracts are presented in Table 3. The differences in the amount of TP and TF may be due to varied efficacy of the extracting
Table 4. Antimicrobial activity and minimum inhibitory concentration of *Amaranthus viridis* leaf and seed methanolic extracts against the selected strains of bacterial and fungal strain.

<table>
<thead>
<tr>
<th>Part of plant used</th>
<th>Extracts</th>
<th><em>S. aureus</em></th>
<th></th>
<th><em>E. coli</em></th>
<th></th>
<th><em>F. solani</em></th>
<th></th>
<th><em>R. oligosporus</em></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Zone size</td>
<td>MIC</td>
<td>Zone size</td>
<td>MIC</td>
<td>Zone size</td>
<td>MIC</td>
<td>Zone size</td>
<td>MIC</td>
</tr>
<tr>
<td>Leaves</td>
<td>100% Methanol</td>
<td>24 ± 1.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>179 ± 1.28&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16 ± 1.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>398 ± 1.26&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17 ± 1.8&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>436 ± 1.46</td>
<td>19.0 ± 1.4</td>
<td>302 ± 1.36&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>23 ± 2.4&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>182 ± 1.68&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>12 ± 0.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>603 ± 2.36&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15 ± 2.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>491 ± 1.76&lt;sup&gt;b&lt;/sup&gt;</td>
<td>18.0 ± 0.9</td>
<td>352 ± 2.42&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Seeds</td>
<td>100% Methanol</td>
<td>16 ± 2.1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>428 ± 1.36&lt;sup&gt;c&lt;/sup&gt;</td>
<td>11 ± 1.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>639 ± 1.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13 ± 1.7&lt;sup&gt;c&lt;/sup&gt;</td>
<td>602 ± 1.89&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.0 ± 1.0</td>
<td>482 ± 1.27&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>80% Methanol</td>
<td>18 ± 1.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>403 ± 2.36&lt;sup&gt;c&lt;/sup&gt;</td>
<td>10 ± 1.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>645 ± 1.48&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10 ± 1.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>641 ± 2.38&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13.0 ± 1.6</td>
<td>547 ± 2.38&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Control</td>
<td>Methanol</td>
<td>26 ± 3.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>141 ± 1.31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17 ± 1.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>381 ± 2.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18 ± 1.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>391 ± 2.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16 ± 2.1</td>
<td>436 ± 2.17&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Values are mean ± SD of three samples analyzed individually in triplicate. Diameter of inhibition zone (mm) including disc diameter of 6 mm and MIC in µg/ml. Controls used are rifampicin and telurazole for bacterial and fungal strains, respectively. Different letters in superscript indicate significant differences within solvents.

Solvents to dissolve endogenous compounds. The ability of different solvents to extract TP and TF contents was of the order: for leaf 80% > 100% methanol and for seed 100% > 80% methanol. These values were higher than the reported values of *A. cruentus* (0.3 g/100 g) (Nsimba et al., 2007). Gorinstien et al. (2007) showed from the values obtained in their work, less phenolic content compared to the four reported *Amaranthus* varieties (107 g/kg). Amaranth plants have been reported as one of many vegetables rich in antioxidant compounds (Obadoni and Ochuko, 2001). The other reported total phenolic contents (TPC) for *Amaranthus* species ranged from 2.95 - 3.75 GAE, mg/100 g (Pasko et al., 2009).

**Antimicrobial activity**

The antimicrobial activity for *A. viridis* leaf and seeds extracts against food-borne and pathogenic microorganisms is depicted in Table 4. The extracts showed considerable antimicrobial activity against all the strains tested, particularly against Gram-positive bacterium. The results from MIC indicated that *E. coli* was most sensitive microbe tested, showing the largest inhibition zones (24 mm) for leaves and minimum (18 mm) for seeds extracts. The least activity is inhibited by 80% methanol seeds extract against *R. oligosporus*, with the smallest zone (13 mm).

In general, the antimicrobial activity of the tested *A. viridis* leaves and seeds extracts was comparable with the standard drugs, streptomycin and mecanzol. In support to our present data, in a previous study, isolation of the antifungal peptide from the *A. viridis* seed extracts has been done (Lipkin et al., 2004). Resazurin is an oxidation-reduction indicator used for the evaluation of cell growth. The effectiveness of resazurin oxidation compound is higher for the leaves extracts of selected Amaranth species. The currents results support the earlier findings which demonstrate the presence of antimicrobial activity in seeds of Amaranthaceae (Cia et al., 2005).

**Conclusion**

The results from the current study indicate that *A. viridis* leaves and seeds extracts contained varied types of pharmacologically active compounds with antioxidant and antimicrobial activities which differed between the two parts and extraction solvents used. Further research work involving more detailed *in vitro* and *in vivo* investigations to establish which component of the extracts offer best antioxidant and antimicrobial activity is needed. Detail toxicological studies are also recommended to explore the uses this plant extracts as natural food preservative. The production of bioactive components from such indigenous resources and their utilization as potential natural food preservatives could be of high economic value.

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