Nutritional composition, vitamins, minerals and toxic heavy metals analysis of *Digera muricata* (L.) Mart.: A wild edible plant from Peshawar, Pakistan

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This study was aimed to assess the nutritional potential of an unexplored wild edible plant, *Digera muricata* (L.) Mart. commonly used as food in Peshawar, Khyber Pakhtunkhwa, Pakistan. The nutritional, vitamins, minerals and trace elements were investigated, using standard methods of Association of Official Analytical Chemists (AOAC). Nutritional assessment included determination of moisture, ash, lipid, fiber, protein, carbohydrate, and energy. Among the nutrient values, fiber was found to be the highest, followed by ash, carbohydrates, moisture and protein. Lipid was present in very small quantity. The vitamins analyzed were found to have greater value for riboflavin than retinol. Among the macro minerals, potassium was present in high concentration than sodium. The trace elements were assessed using atomic absorption spectrophotometer (AAS) and their decreasing order was Fe>Zn>Mn>Co>Ni. Two toxic metals, Pb and Cd were present in very minute quantities. From the results it was suggested that *D. muricata* (L.) Mart. is a useful plant and can be used as food.

Key words: *Digera muricata* (L.) Mart., nutritional evaluation, vitamins, minerals, Association of Official Analytical Chemists (AOAC).

INTRODUCTION

Nutrition is one of the most important basic needs of humans, for good health, labour productivity, and mental development. Hunger and malnutrition are the problems, increasing in most of the developing countries, due to high rate of population growth, shortage of fertile land and high food prices. Protein deficiency for instance is widespread and has been cited as the most common form of malnutrition in the developing world (Pelletier et al., 1995). Plants have been handled by human societies for food purposes, since time immemorial. It is true that today, human plant food based on mainly twelve crops, which contribute more than 85 to 90% of the total world’s caloric intake, but it is also a fact that in many parts of the world, the use of wild plants is not negligible (Prescott-Allen and Prescott-Allen, 1990; Scherrer et al., 2005; Bussmann et al., 2006; Bussmann and Sharon, 2006; Kunwar et al., 2006; Cavender, 2006; Pieroni et al., 2007; Hussain et al., 2009a). Green leafy vegetables have been recognized for their nutritional importance. They are rich sources of protein contents, ascorbic acid, carotene, folic acid, riboflavin, and minerals like calcium, iron and phosphorus (Kris-Etherton et al., 1988; NRC, 1996; Osler et al., 2001; Sheela et al., 2004). Wild edible green plants are commonly found in countries with rather varied climates. Many researchers have shown several wild species of vegetables fit for human consumption. In some modern cultures people consume wild plants as a normal food.
source, to obtain good amounts of several nutrients and it
is widely accepted that leafy green vegetables are sig-
ificant nutritional sources of minerals (Grau et al.,

Many workers have reported the compositional eval-
uation and functional properties of various types of
edible wild plants in use in the developing countries
around the world (Lockeett et al., 2000; Akindahunsi and
Salawu, 2005; Edeoga, 2006; Hassan and Umar, 2006;
Ekop, 2007; Mohan and Kalidass, 2010; Gafar and Itodo,
2011; Vishwakarma et al., 2011; Valvi and Rathod, 2011;
Naryan et al., 2011; Seal, 2011). In Pakistan, wild
vegetables are used as food in both urban and rural
areas. The researchers have investigated several wild
plants of Pakistan, for nutritional composition (Khattak et
al., 2006; Imran et al., 2007; Qureshi and Bhatti, 2009;
Hussain et al., 2009; Marwat et al., 2010; Jan et al.,
2011; Khan et al., 2011). The database of the nutrient
and chemical compositions of these plant foods is still
incomplete and much work is still needed to be done.

Many of the local wild vegetable materials are under-
exploited in Pakistan because of inadequate scientific
knowledge of their nutritional potentials. *Digera muricata*

is a common weed found during the summer season
throughout the plains of Pakistan. It is an annual herb,
growing to 20 to 70 cm tall. Stems are simple or
branched from the base, nearly hairless. Alternately
arranged leaves, 1 to 9 cm long and 0.2 to 5 cm broad,
are narrowly linear to broadly ovate. Leaf stalks are long,
up to 5 cm, base is narrowed, and the tip pointed.

Flowers are hairless, white mixed with pink to carmine
or red, usually becoming greenish-white in fruit (Qureshi
and Bhatti, 2009; Khan et al., 2011). This plant has been
proved very useful for several pharmacological applica-
tions in the past. Antioxidant properties of *D. muricata*
against the CCl₄-induced toxicity have been documented
for testis and kidneys (Khan and Ahmed, 2009; Khan et
al., 2009). The protective role of *D. muricata* against
CCl₄-induced oxidative stress in thyroid had been
reported by Khan et al. (2011).

In Pakistan and India, the young leaves and shoots
are made into curries. To the best of our knowledge, there is
no report on nutritional evaluation of *D. muricata* (L.)
Mart. This study was designed to evaluate the nutritional
status, vitamins, minerals and trace elements analysis of
*D. muricata* (L.) Mart. a wild edible plant, commonly
consumed as food by the people of Peshawar, Pakistan.
Information about the selected plant is given in Table 1
(USDA, 2012).

MATERIALS AND METHODS

Plant

The plant was collected from Peshawar region, agriculture fields of
the corresponding author, from July to November, 2011. Fifteen
samples were collected from different fields and each sample was
studied in triplicate, thus making a total of 45 samples analyzed.

Standard methodology was used for collection of plant samples
(Humphry, 1993). Specific samples were obtained with the aid of
interpreters and field guides. Genus and species was identified by
plant taxonomist professor, Ifthikhar Alam Khattak, by comparison
with herbarium reference materials at Agriculture University
Peshawar. The voucher specimen was preserved in Department of
Plant Sciences, KUST, Kohat, for future references. The plant
leaves were shed dried, pulverized and stored in an airtight
container.

Nutritional composition

Moisture was determined by keeping the sample in oven at 100 to
110°C for overnight. The loss in weight was regarded as a measure
of moisture content. For ash content, the sample was heated in
muffle furnace at 550°C, until white or grayish white ash was
observed. The weight of the ash was noted directly. Crude fibre was
measured by treatment of the sample with 1.25% H₂SO₄, 1.25%
NaOH and then 1% HNO₃, filtered and washed with hot water after
each step. The residue obtained was dried in oven at 130°C and
ashed at 550°C in furnace. The loss in weight on ignition was
expressed as the content of crude fiber total lipid was extracted from
the sample with petroleum ether (60 to 80°C) in a Soxhlet
apparatus for about 6 to 8 h. The residual solvent was evaporated
in a preweighed beaker and increase in weight of beaker gave total
lipid (AOAC, 2000).

Total lipid content was fractionated into saponifiable and non-
saponifiable lipids by the saponification of total lipid followed by
extraction of non-saponifiable fraction with petroleum ether, 40-60
°C (AOCS, 1993). Nitrogen content in the sample was estimated by
using micro Kjeldahl method and crude protein was calculated by
multiplying the evaluated nitrogen by 6.25. The value of total
carbohydrate was given by: 100-(percentage of ash + percentage of
total lipid + percentage of protein + percentage of crude fibre)
(AOAC, 2000). The caloric value was calculated by multiplying the
values of total carbohydrate, lipid and protein by the factors 4, 9
and 4, respectively, taking the sum of the products and expressing
the result in kilocalories (Guill-Guerrero et al., 1998).

Vitamins analysis

Vitamin A was estimated by extraction with ethanol and then mixing
with petroleum ether. The amount in extract was determined by UV-
Visible Spectrophotometer (Hitachi U-2000, Japan), at 450 nm, using
(Fiskelova 2008).

For riboflavin (vitamin B₂), the ethanol extract was added to
potassium permanganate and H₂O₂ and allowed to stand over hot
water. Then 40% sodium sulphate was added and the absorbance
was measured at 510 nm by spectrophotometer (James, 1995).

Minerals and toxic heavy metals analysis

Two macro minerals sodium and potassium were estimated by
using flame photometer (Model 410 Corning, Germany). Standard
solution of each was used for calibration of the instrument before
analysis (AOAC, 2000). The micro minerals including Zn, Cu, Ni,
Mn, and Fe along with toxic heavy metals Pb and Cd, were
determined, by wet digestion of the sample followed by analysis
using atomic absorption spectrophotometer (A-Analyst 700 Perkin
Elmer/USA) equipped with standard burner, air acetylene flame and
hollow cathode lamps, as radiation source (Indrayan et al., 2005).

Statistical analysis

The data obtained from three replicates were analyzed by ANOVA
using the SPSS statistical package program, and the differences between the means were compared using the Duncan’s multiple range tests at the significance level of 0.05. Values for the same parameter among various samples were represented by superscript a or b, when p<0.05 or p>0.05 respectively (Tables 2, 3 and 4).

### RESULTS AND DISCUSSION

#### Nutritional composition

Moisture in food is a source of water and is considered necessary that 20% of the total water consumption must come from food moisture (FNB, 2005). The average moisture content of the sample leaves studied was 13.88% (Table 2), which showed that the leaves were rich in minerals. The value obtained was higher as compared to 1.8% reported in sweet potato leaves, and 5% in Tribulus terrestris leaves, 1.85% in A. viridis leaves, 2.70% in C. murale leaves, 1.77 and 3.10%, in N. officinale and S. pecten-veneris leaves respectively. But lower than 19.61% in Amaranthus hybridus leaves (Imran et al., 2007).

The crude protein content of the sample was found to be 8.75% (Table 2). This value was higher as compared to 2.11% in A. viridis, 2.98% in C. murale leaves, 2.76% in N. officinale, 6.30% in water spinach and 6.40% in Momordica foecide leaves (Imran et al., 2007). But lower than 11.29% in balsam apple leaves, 24.85% in sweet potato leaves, Piper guineense and Talinum triangulare with values of 29.78 and 31.00%, respectively (Akindahunsi and Salawu, 2005). Among the reported wild edible plants of the same family, sample leaves contain higher crude protein value. According to the WHO recommended dietary allowance (RDA) of protein, for children, adult male and adult female is 28, 63 and 50 g, respectively (Akindahunsi and Salawu, 2005), while in Pakistan the average protein intake is 43.4 g/day (Figure 1) (NNSP, 2011). As the plant protein is also considered

<table>
<thead>
<tr>
<th>S/N</th>
<th>Nutritional parameter</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mg/g±SD</td>
</tr>
<tr>
<td>1</td>
<td>Moisture</td>
<td>139±3.2</td>
</tr>
<tr>
<td>2</td>
<td>Ash</td>
<td>181±4.2</td>
</tr>
<tr>
<td>3</td>
<td>Total lipid</td>
<td>50±2.2</td>
</tr>
<tr>
<td>4</td>
<td>Lipid Saponifiable</td>
<td>32±1.2</td>
</tr>
<tr>
<td>5</td>
<td>Non saponifiable</td>
<td>18±0.8</td>
</tr>
<tr>
<td>6</td>
<td>Total Protein</td>
<td>88±2.6</td>
</tr>
<tr>
<td>7</td>
<td>Fiber</td>
<td>410±3.8</td>
</tr>
<tr>
<td>8</td>
<td>Carbohydrate</td>
<td>133±2.7</td>
</tr>
<tr>
<td>9</td>
<td>Energy (kcal/100 g)</td>
<td>1.4×10⁵</td>
</tr>
</tbody>
</table>

*P<0.05; bP>0.05.

#### Table 1. Description of the sample plant analyzed.

<table>
<thead>
<tr>
<th>Vernacular names</th>
<th>Scientific classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>English, False amaranth; Urdu, Lesua; Pashtu, Sur gulae; Hindi, Latmahuria; Sanskrit, Aranya; Marathi, Gitana; Telugu, Chenchhali koora; Arabic, Alqattoeq - alkazebat</td>
<td>Kingdom Plantae</td>
</tr>
<tr>
<td></td>
<td>Subkingdom Tracheobionta</td>
</tr>
<tr>
<td></td>
<td>Super division Spermatophyta</td>
</tr>
<tr>
<td></td>
<td>Division Magnoliophyta</td>
</tr>
<tr>
<td></td>
<td>Class Magnoliopsida</td>
</tr>
<tr>
<td></td>
<td>Subclass Caryophyllidae</td>
</tr>
<tr>
<td></td>
<td>Order Caryophyllales</td>
</tr>
<tr>
<td></td>
<td>Family Amaranthaceae</td>
</tr>
<tr>
<td></td>
<td>Genus Digera</td>
</tr>
<tr>
<td></td>
<td>Species Digera muricata (L.) Mart.</td>
</tr>
</tbody>
</table>
Nutritional composition of *Digera muricata* (L.) Mart.

![Graph showing nutritional composition with RDA and DI Pakistan]

**Figure 1.** Nutritional composition in comparison with RDA and average nutrient intake in Pakistan.

**Table 3.** Vitamins constituents of *Digera muricata* (L.) Mart.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Vitamin</th>
<th>Quantity</th>
<th>mg/g±SD</th>
<th>%</th>
<th>mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vitamin A</td>
<td></td>
<td>0.0115±0.013</td>
<td>1.15×10⁻³</td>
<td>11.5</td>
</tr>
<tr>
<td>2</td>
<td>Riboflavin (Vit B₂)</td>
<td></td>
<td>0.0204±0.015</td>
<td>2.04×10⁻³</td>
<td>20.4</td>
</tr>
</tbody>
</table>

*P<0.05

**Table 4.** Minerals and toxic heavy metals of *Digera muricata* (L.) Mart.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Mineral</th>
<th>Quantity</th>
<th>mg/g</th>
<th>%</th>
<th>mg/kg±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Macro-minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Sodium</td>
<td>0.08</td>
<td>7.60×10⁻³</td>
<td>76.0₀⁺±4.0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Potassium</td>
<td>0.76</td>
<td>7.60×10⁻²</td>
<td>760.0₀⁺±23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Micro-minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Zinc</td>
<td>2.98×10⁻³</td>
<td>2.30×10⁻⁴</td>
<td>2.296⁺±0.07</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Copper</td>
<td>6.29×10⁻⁴</td>
<td>6.29×10⁻⁵</td>
<td>0.629⁺±0.02</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Iron</td>
<td>2.08×10⁻⁵</td>
<td>2.08×10⁻³</td>
<td>20.75⁺±0.61</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Manganese</td>
<td>1.71×10⁻⁴</td>
<td>1.71×10⁻⁴</td>
<td>1.706⁺±0.06</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Nickel</td>
<td>2.30×10⁻⁴</td>
<td>2.30×10⁻⁵</td>
<td>0.230⁺±0.002</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toxic heavy metals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Lead</td>
<td>5.06×10⁻⁴</td>
<td>5.06×10⁻⁵</td>
<td>0.506⁺±0.01</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Cadmium</td>
<td>1.90×10⁻⁴</td>
<td>1.90×10⁻⁶</td>
<td>0.019⁺±0.002</td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05; *P>0.05.

Lipid in food is considered as a chief source of storage form of energy, essential fatty acids and fat soluble vitamins and precursors of vitamins. The sample leaves contained 5.0 % crude lipid (Table 1). It was lower than 11 % in water spinach leaves, 12 % in *Senna obtusifolia*, 11 % in *Amaranthus caudatus* leaves, 28.2 % in *Centilla asiatica* leaves, 29 % in *Babunian purpurea* leaves, and 60% in *Amaranthus hybridus*, but higher than 0.47% in *Amaranthus viridus*, 0.54% in *Chenopodium murale* and 0.63 % in *Scandix pecten-veneris* leaves (Imran et al., 2007). The crude fiber content of sample leaves was 41 % which was higher, compared to 7.20 % in sweet potato leaves, 13 % in *Tribulus terrestris* leaves, 29.0 % in balsam apple leaves, 1.93 % in *Amaranthus viridus*, 3.82 % in *Scandix pecten-veneris* leaves (Akindahunsi and Salawu 2005). Dietary fiber helps to reduce serum cholesterol level, risk of coronary heart diseases, colon and breast cancer and hypertension. The high level of fiber in diet can cause intestinal irritation, lower digestibility, difficult absorption of minerals found in plant and overall decrease nutrient utilization (Imran et al., 2007).

The carbohydrate content of sample leaves was 13.31%, considerably low when compared with other wild edible plants such as *A. caudatus* leaves (61.03%), 55.67% in *T. terrestris*, 54.2% in water spinach leaves, 75% in sweet potato leaves, 82.8% in *Corchorus tridens* leaves. But higher when compared with *A. viridus*, C.
murale, N. officinale and S. pecten-veneris leaves, that is, 4.74, 3.41, 3.38 and 7.32%, respectively (Imran et al., 2007). Carbohydrates are principal and indispensable source of energy. The RDA for carbohydrates is 130 g (FAO, 1998), while in Pakistan 349 g of carbohydrate intake is reported (Figure 1) (Ministry of Health and Nutrition, 1994). Due to carbohydrates content sample plant can be a good food source.

The 100 g of D. muricata (L.) Mart. provide 140 kcal of energy. This reveals that the sample plant can contribute meaningfully to the daily energy requirement of a person. The caloric value of D. muricata (L.) Mart. is high as compared to A. viridis (31.63 kCal), S. pecten-veneris (50.23 kcal) (Imran et al., 2007), 134.6 Kcal of Aegle marmelos. But lower when compared with A. caudatus 326.7 Kcal, Dioscorea bulbifera 304.7 kcal and 333.1 kcal of Ficus bengalensis (Imran et al., 2007).

Vitamin analysis

The sample contained 1.15 mg / 100 g of vitamin A (Table 3). The RDA for vitamin A is 1.5 mg / 100 g (Figure 2). The result showed that the sample was a good source of vitamin A. Vitamin A is necessary for vision process and also plays a role in skin mucosa, normal reproductive capabilities and is an important antioxidant (FAO 2001). The sample contained 2.04 mg /100 g of vitamin B2. The RDA for riboflavin is 1.7 mg. The results showed that it was a rich source of riboflavin. Riboflavin is present in body as co – enzyme which acts as hydrogen acceptor in amino acid metabolism (FAO 2001). The riboflavin content was lower than sonchus eruca and sonchus asper (Hussain et al., 2010).

Minerals analysis

Sodium maintains fluid volume outside the cell thus normalize the cell functions. The sodium content of the sample was 76 mg/kg (Table 4), slightly low as compared to that reported for T. terrestris leaves (50 mg/g) and 450 mg/kg in S. obtusifolia but quite high in comparison to Asparagus officinalis (0.184 mg/kg) and Momordica dioica (0.151 mg/kg) (Khan et al., 2011). The RDA for sodium is 500 mg for adults (Figure 3). The plant sample leaves can be good source of food for hypertensive patients (FAO, 2001). Potassium content of the sample was 760 mg/kg (Table 4), high as compared to other green leafy vegetables as 64.2 mg/kg was found in Diospyros mespiliformis, 1.09 mg/kg in A. officinalis, 0.825 mg/kg in M. dioica and 4.409 mg/kg in Indigofera australagina (Khan et al., 2011). The RDA for potassium is 2500 mg for adults (Figure 3), and the sample contributes 30% to RDA, meaning the good source that can contribute to the diet of hypertensive patients (FAO, 2001).

Microminerals analysis

The copper content of plant sample was 0.629 mg/kg (Table 3), which is higher as compared to 0.1 mg/kg in D. mespiliformis and 0.25 mg/kg in Ficus bengalensis, but lower when compared with 12.8 mg/kg in T. terrestris leaves and 5.0 mg/kg in Cassia siamea leaves (Khan et al., 2011; Gafar and Itodo, 2011). The RDA value for copper is 1 to 3 mg for adult (Figure 4). Copper contributes a role in hemoglobin formation and plays role in iron and energy metabolism (FAO, 2001). The zinc content of the sample leaves was found to be 2.2984 mg/kg, higher as compared to 0.200 mg/kg in D. mespiliformis, 1 mg/kg in T. terrestris leaves but lower when compared with 68.5 mg/kg in C. siamea (Khan et al., 2011; Gafar and Itodo, 2011). Zinc plays a vital role in gene expression, regulation of cellular growth and participates as a cofactor of many enzymes. It also plays an important role in motility of sperm during liqueation and mating. The RDA of zinc is 12 to 15 mg for adults (FAO, 2001).

Iron content of the sample was 20.75 mg/kg, higher than other vegetables, but lower than Cassia siamea 700 mg/kg (Khan et al., 2011). The RDA value of iron is 10 to 15 mg/100 g. This sample is a good source of iron. Iron is required for hemoglobin formation and its deficiency leads to anemia (FAO, 2001). Manganese content of plant sample was 1.706 mg/kg which is lower than 9.8 to 38 mg/kg reported in some leafy vegetables and 116 mg/kg in balsam apple leaves (Khan et al., 2011). The RDA for manganese is 2 to 5 mg. The result showed that D. muricata L. is a good source to provide daily manganese. Manganese is a co-factor for many enzymes which take part in glucose and amino acid metabolism (FAO, 2001). The amount of nickel present was 0.203 mg/kg in the sample. This quantity was quite lower when compared with other edible wild plants like F. bengalensis 1.14 mg/kg (Gafar and Itodo, 2011). Nickel is needed in very small amount to the body. The health benefits of Ni are healthy skin and optimal growth and also take part in iron metabolism. Higher quantity leads to toxicity (Gafar and Itodo, 2011).

Toxic heavy metals analysis

The lead content of sample was 0.506 mg/kg (Table 4), higher as compared to F. bengalensis (0.25 mg/kg). Lead is toxic and non essential element for human body as it causes rise of blood pressure, kidney damage, miscarriage, subtle abortion, brain damage, decline fertility of men through sperm damage and diminishes learning abilities due to neuron damaging actions (Gafar and Itodo, 2011). Cadmium concentration of D. muricata (L.) Mart. was 0.019 mg/kg higher as compared to F. bengalensis 0.017 mg/kg and lower than other usual edible plants. Cadmium is highly toxic for a body and it
Vitamins content of *Digera muricata* (L.) Mart.

![Chart showing vitamins content comparison with RDA](image)

**Figure 2.** Vitamins content in comparison with RDA.

Macromineral composition of *Digera muricata* (L.) Mart.

![Chart showing macromineral composition comparison with RDA](image)

**Figure 3.** Sodium and potassium contents in comparison with RDA.

Microminerals composition of *Digera muricata* (L.) Mart.

![Chart showing microminerals composition comparison with RDA](image)

**Figure 4.** Microminerals in comparison with RDA.
cause a several health hazards, including cell death and cell proliferation (Gafar and Itodo, 2011).

Conclusions

*D. muricata* (L.) Mart. has good proximate values of moisture, fiber, proteins, and carbohydrates. The macro minerals (Na and K), micro minerals (Fe, Cu, Ni and Mn), and vitamins (A and B₂) are also present in appreciable quantity. The toxic metals like Pb and Cd are present in very minute amount and therefore do not pose any threat to health. These results are making the plant a good source of food and can be recommended for edible uses.

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