ABSTRACT

Green leafy vegetable consumption has been associated with a decreased risk of persistent metabolic diseases. In the present work nutritional potential, secondary metabolites and antioxidant capacity of four leafy vegetables from Ratnagiri district were assessed and compared. The moisture content in the vegetables ranged from 87.02-91.42%. Crude fiber and protein content were high in Clerodendrum serratum (17.2% and 14.54% respectively). Celosia argentea showed the highest percentage of ash (13.7%). Lipid content ranged between 1.6-2.73%, while carbohydrates were highest in Amorphophallus paeoniifolius. Among the various macronutrients estimated in these wild leafy vegetables calcium was present in the highest quantity (3931mg/100g) followed by sodium (660mg/100g) and magnesium (468mg/100g). Micronutrients such as zinc, copper, iron, cobalt were present in optimum concentration in these vegetables. The total antioxidant capacity ranged from 41.14-169.81mg/g being highest in the ethanolic extract of Clerodendrum serratum. These vegetables were found nutritionally adequate and also possessed a significant antioxidant potential.

Keywords: Wild leafy vegetables, Proximate analysis, Minerals, Antioxidant activity.

INTRODUCTION

Green leafy vegetables are rich source of vitamins such as beta carotene, ascorbic acid, riboflavin, folic acid as well as minerals like iron, calcium, phosphorus etc. They are also recognized for their color flavor and therapeutic value. Some of the commonly consumed leafy vegetables viz. amaranth, spinach, fenugreek, coriander are analyzed for their nutritive
value \cite{1}. Bhaskarachary \textit{et al}.,\cite{2} have reported some less familiar, green leafy vegetables which are rich sources of beta carotene. There are a great variety of seasonal leafy vegetables available during the post monsoon season in the coastal region of Maharashtra. In the present study phytochemical and nutritional composition of four wild leafy vegetables from the Ratnagiri district, namely, \textit{Amorphophallus paeoniifolius} (Dennst.)(Suran), \textit{Cassia tora} L. (Takala) , \textit{Celosia argentea} L.(Kurdu) and \textit{Clerodendrum serratum} L.(Bharangi) has been reported.

**MATERIALS AND METHODS**

Vegetable samples were collected from natural habitat at different places from Ratnagiri District during monsoon (June to September 2012). The leaves and young shoots were washed to remove soil debris and dust, blotted to dry and used for moisture determination. Edible portion of vegetables were dried in hot air oven at 45°C. Dried material was powdered in a grinder and then stored in air tight containers, protected from moisture and light, for further use.

**Phytochemical Screening**

Qualitative analysis of vegetable samples was carried out to detect the presence of phytochemical constituents using standard procedures described by Horborne \cite{3}. Ethanol and acetone extracted samples were used for this study. The extracts were prepared by suspending 1g of dry powder in 10ml of respective solvent in a conical flask. These samples were shaken for 12h on a rotary shaker. The extracts were filtered, centrifuged and the supernatants were saved for analysis.

**Fluorescence Analysis**

Fluorescence analysis was carried out by following the method given by Chase \textit{et al}.,\cite{4}. Powdered vegetable samples were treated with different reagents and color change was recorded on exposure to UV and visible light.

**Proximate analysis**

Proximate composition included determination of moisture, ash, crude fiber, total lipid, total protein, carbohydrates and minerals. Moisture content was determined using a moisture balance. Ash content was recorded by following the procedure given in AOAC \cite{5}. Crude fiber and total protein were evaluated by the methods described in Sadasivam and Manickam\cite{6}. Total lipid content was estimated by the method of Folch \textit{et al}.,\cite{7} and
carbohydrates were analyzed using Anthrone method [6]. For mineral analysis sample were digested using conc. HNO3 and perchloric acid (Toth et al.,[8]. The acid digest was used for mineral analysis employing atomic absorption spectrophotometer (Perkin Elmer, USA).

**Total antioxidant capacity**
Antioxidant capacity of ethanol, methanol and aqueous extracts of vegetables was determined according to Prieto et al [9].

**RESULTS AND DISCUSSION**
Preliminary phytochemical screening indicated presence of a wide array of phytochemicals including phenols, alkaloids, flavonoids, tannins, saponins, glycosides, coumarins and quinines in all the vegetables (Table 1). Most of the constituents were present in both the extracts of vegetables. Quinine was present only in *C. tora* while glycosides occurred only in ethanolic extracts of *C. tora* and *C. argentea*. Glycosides, alkaloids, steroids, and tannins have been reported to be present in *Bidens biternata* from Western Ghats [10].

Fluorescence is the phenomenon exhibited by various chemical constituents present in the plant material. Some Constituents show fluorescence in the visible range in day light. The ultraviolet light produces fluorescence in many natural products (e.g. Alkaloids like Berberine) which do not visibly fluoresce in day light. The color changes observed under visible and ultraviolet light in different vegetable samples in the present study are reported in Table 2. Most of the samples appeared dark colored under UV light.

**Table 1. Phytochemical Analysis**

<table>
<thead>
<tr>
<th>Name of the vegetable</th>
<th>Phenol</th>
<th>Alkaloid</th>
<th>Flavonoid</th>
<th>Saponin</th>
<th>Tannin</th>
<th>Quinine</th>
<th>Glycosides</th>
<th>Coumarin</th>
</tr>
</thead>
<tbody>
<tr>
<td>E         A         E</td>
<td>A      E       A     E</td>
<td>A      E       A     E</td>
<td>A      E       A     E</td>
<td>A      E       A     E</td>
<td>A      E       A     E</td>
<td>A      E       A     E</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amorphophallus paonifolius</em></td>
<td>+     +       +     +</td>
<td>+     +       +     +</td>
<td>+     _       +     _</td>
<td>+     _       _     _</td>
<td>+     _       _     _</td>
<td>+     _       _     _</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Cassia tora</em></td>
<td>+     +       +     +</td>
<td>+     +       +     +</td>
<td>_     _       +     _</td>
<td>+     +       +     _</td>
<td>_     _       _     _</td>
<td>+     +       +     +</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Celosia argentea</em></td>
<td>+     +       +     +</td>
<td>+     +       +     +</td>
<td>_     _       _     _</td>
<td>_     _       _     _</td>
<td>+     +       _     _</td>
<td>+     +       +     +</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Clerodendrum serratum</em></td>
<td>+     +       +     +</td>
<td>+     +       +     +</td>
<td>_     _       _     _</td>
<td>_     _       _     _</td>
<td>_     _       _     _</td>
<td>_     _       _     _</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

E- Ethanol
A- Acetone
Table 2. Fluorescence Analysis

<table>
<thead>
<tr>
<th>Name of the vegetable</th>
<th>Powd. + 50% HCl</th>
<th>Powd. + 50% HNO₃</th>
<th>Powd. + Ethanol</th>
<th>Powd. + FeCl₂</th>
<th>Powd. + 10% NaOH</th>
<th>Powd. + 5% KOH</th>
<th>Powd. + Acetic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amorphophallus paeoniifolius</td>
<td>Gr</td>
<td>Br</td>
<td>Y. Gr</td>
<td>O. Gr</td>
<td>Br</td>
<td>O. Gr</td>
<td>Gr</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>Gr</td>
<td>D. Gr</td>
<td>Y. Gr</td>
<td>Gr</td>
<td>O. Gr</td>
<td>D. Gr</td>
<td>O. Gr</td>
</tr>
</tbody>
</table>

Bl-Black, Br-Brown, D-Dark, Gr-Green, O-Olive, Or-Orange, Y-Yellowish

Proximate Analysis

Nutritional composition of four leafy vegetables is shown in Figure 1. Moisture content varied from 87.02% in *Clerodendrum serratum* to 91.42% in *Celosia argentea*. A high moisture content provides a greater activity of water soluble enzymes and co enzymes needed for metabolic activities of these leafy vegetables [11]. The moisture content was comparable to other wild vegetables like *Amaranthus viridis*, *Chenopodium murale*, *Nastrium officinale* and *scandex pectin veredis* where it was above 80% [12]. Like the moisture content, ash is also very important from biochemical point of view. Ash contains all the important nutritional ingredients especially minerals, both macro and microelements which are very important for the normal physiological functions of the body. Percent ash content ranged from 4.6% in *Clerodendrum serratum* to 13.7% in *Celosia argentea*. A high ash content was found in wild vegetables of Malaysia (13-17.6%) [13].

Crude fiber content was more than 10% in all the samples and maximum in *C. serratum* (17.2%). Sharma *et al.*, [14] reported a high crude fiber content in *Moringa oleifera* (19.25%). Lipid content of all vegetables ranged between 1.6 – 2.7%. The lipid content in the present study was comparable to that reported for some common vegetable like *Colocasia esculenta* (2%) [15]. Protein content was higher in *C. serratum* and *C. tora* while carbohydrates were greater in *A. paeoniifolius*. Gopalan *et al.*, [16] have reported very high carbohydrates in some conventional leafy vegetables. *Moringa oleifera* from Chhattisgarh, India and sweet potato leaves are reported to be rich in carbohydrates [17, 18].
Mineral Analysis

Mineral elements of the vegetables are presented in Table 5. Calcium is an important dietary mineral for strong bones and muscle/neurological functions. *C. tora* had a high calcium content (3.931g/100g) as compared to other vegetables. Kubmarwa *et al.* [19] have reported a high calcium content in *Cassia tora* (3.52g/100g) and *Celtis integrifolia* (3.70g/100g). Magnesium content of *C. tora* and *C. serratum* was higher than other two vegetables (0.468g/100g and 0.308g/100g respectively). In *Tricyrtis pillosa* from Meghalaya states of India 0.845mg/g magnesium is reported [20]. Magnesium is important mineral required for cellular metabolites and leafy green vegetables are very good source of magnesium. Phosphorus was maximum (142mg/100g) in *A. paeoniifolius* followed by *C. argentea* (104mg/100g). A high amount of phosphorus was found in *Taraxicum officinale* (420mg/100g) from Pakistan [21]. Iron is important in the formation of haemoglobin of blood. From the results, *C. serratum* had the highest concentration of iron (55.84mg/100g) while the lowest content was found in *C. argentea* (8.94mg/100g). Chaturvedi *et al.*, [22] reported higher values of iron in *Basella alba* (21.3mg/100g) and lower values in *Spinacea oleracea* (12mg/100g) from Rajasthan, India.

Regular addition of green leafy vegetables in the diet may help in preventing the adverse effect of zinc deficiency such as growth retardation. Total zinc content of vegetables ranged from (5.36 – 12.1mg/100g). Copper content of all samples ranged between 1.26mg/100g-5.84mg/100g. Cobalt content was found highest in *C. serratum* (0.84mg/100g) and lowest in
A. paeoniifolius (0.12mg/100g). In the present study sodium content was in the range of 160-221 mg/100g. Gupta et al.,[23] reported a large sodium content in Celosia argentea and Centella asiatica (240.6mg/100g and 107.8mg/100g respectively).

Table 4. Mineral Content of Leafy Vegetables (mg/100g dry vegetables)

<table>
<thead>
<tr>
<th>Name of the vegetable</th>
<th>Ca</th>
<th>Mg</th>
<th>P</th>
<th>Zn</th>
<th>Cu</th>
<th>Fe</th>
<th>Co</th>
<th>Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amorphophallus paeoniifolius</td>
<td>129</td>
<td>98</td>
<td>142</td>
<td>12.1</td>
<td>1.26</td>
<td>17.02</td>
<td>0.12</td>
<td>161</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>3931</td>
<td>468</td>
<td>84</td>
<td>2.8</td>
<td>5.84</td>
<td>48.42</td>
<td>0.78</td>
<td>181</td>
</tr>
<tr>
<td>Celosia argentea</td>
<td>140</td>
<td>61</td>
<td>104</td>
<td>3.7</td>
<td>1.56</td>
<td>8.94</td>
<td>0.70</td>
<td>160</td>
</tr>
<tr>
<td>Clerodendrum serratum</td>
<td>1621</td>
<td>308</td>
<td>48</td>
<td>5.36</td>
<td>4.18</td>
<td>55.84</td>
<td>0.84</td>
<td>221</td>
</tr>
</tbody>
</table>

Total Antioxidant Capacity

This assay is based on the result of the reduction of Mo (VI) to Mo (V) by the sample and formation of a green phosphate Mo (V) complex at acidic pH which has the absorption maximum at 695nm. The ascorbic acid equivalents to vegetables are shown in Table 3. Total Antioxidant Capacity was highest in the ethanolic extract of C. serratum (169.81 mg/g) and lowest in the aqueous extract of C. argentea (41.14mg/g). A higher total antioxidant activity in methanolic extract of Mukia maderspatana (127.1ug/g) and Solanum trilobatum (65.5ug/g) from Tamilnadu has been reported [24]. The antioxidant activity by phosphomolybdenum method may mainly depends on the presence of polyphenols in the samples which may act as reducing agents, by donating the electrons and reacting with free radicals to convert them to more stable products, thus terminating the free radical chain reaction [25]. In the present study methanol and ethanol extracted vegetable samples revealed a significant antioxidant activity.

Table 3. Total Antioxidant Capacity of Wild Leafy Vegetables

<table>
<thead>
<tr>
<th>Name of the vegetable</th>
<th>Methanol</th>
<th>Ethanol</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amorphophallus paeoniifolius</td>
<td>164.57</td>
<td>94.88</td>
<td>117.54</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>102.81</td>
<td>165.96</td>
<td>94.88</td>
</tr>
<tr>
<td>Celosia argentea</td>
<td>64.20</td>
<td>74.18</td>
<td>41.14</td>
</tr>
<tr>
<td>Clerodendrum serratum</td>
<td>116.31</td>
<td>169.81</td>
<td>70.34</td>
</tr>
</tbody>
</table>

Values are expressed in mg/g dry weight

CONCLUSION

The vegetables analyzed in the present study occur naturally and widely and possess an ample amount of carbohydrates, proteins, fibers, minerals and also project a high level of
total antioxidant capacity, These wild vegetables can provide an important nutritional supplement in the diet of coastal people. They are easy to cook and when used regularly can help to eradicate micronutrient malnutrition.

REFERENCES