Food and Nutritional Security through wild edible vegetables or weeds in two district of Jharkhand, India

Sakshi Gupta, Anuradha Srivastava and Eugenia P Lal

Abstract
In present study, 26 species of local underutilized leafy vegetables commonly consumed by tribals of Jharkhand were identified through market survey and local villages of three district of state. Leafy vegetables sold in markets, *Amaranthus viridis* (Gandhari) was found highest in quantity followed by *Centella asiatica* (Beng), *Hygrophila polysperma* (Muchari), *Polygonum plebeium* (Chent) and *Marsilea minuta* (Chatta saag). The leafy vegetables were found to be rich in many nutrients. The antioxidant found maximum in *Colocasia esculenta*. The maximum found in *Amaranthus viridis*. The maximum calcium and magnesium content found in *Vangueria spinosa*. The maximum phosphorous content found in *Oxalis corniculata*. The maximum potassium content found in *Polygonum plebeium*. The maximum sulphur content found in *Centella asiatica*. The maximum zinc content found in *Vangueria spinosa*. The maximum found in *Moringa oleifera*.

Keywords: Underutilized, Leafy vegetables, Jharkhand, Antioxidant, Nutritional.

Introduction
Jharkhand is very rich with respect to the diversity of green leafy vegetables that are cultivated and is collected from wild. These leafy vegetables most often come from short lived herbaceous plants, whereas, leaves or flower of some woody plants are also eaten by local people. During rainy consumed by the natives. A sizable proportion of the consumed leafy vegetables is not and summer season, rural people collect various species of edible weeds from their agricultural and non-agricultural fields as well as from forestland to supplement their staple food. These species consumed by tribal people in the form of leafy vegetables vary from locality to locality and season to season depending on the availability of resources. Such vegetables constitute an integral part of the diet of these tribes as they get these plants in their immediate surroundings without any investment. These leafy vegetables are cooked as saag, eaten raw or dried and stored for uses round year. The diversity of leafy vegetables species offer variety in family diet and contributes to household food and nutritional security as well as increase dietary diversity.

Further, it provides rural household with supplementary income opportunities through their sale in the markets. Many varieties of these underutilized leafy vegetables, both cultivated and wild are sold in these local markets in both fresh and dried form. During the rainy season, a large quantity of these leafy vegetables are harvested and dried in sun, to be consumed with cooked rice water in the form of soup during the lean period when the supply of vegetables is limited and prices are high.

These local leafy vegetables are among the most nutritious vegetables as they are rich sources of minerals such as calcium, magnesium, iron and potassium as well as a good source of vitamins which show wide and essential medicinal use as tradition of these local people or tribes. They are also high in fibre, extremely low fat and carbohydrates, and also provides a fair source of protein. Thus, these leafy vegetables play a significant role in reducing micronutrient deficiency and provides food security to the tribal population of rural Jharkhand, however no systematic information is yet available regarding the consumption pattern and nutritional composition of these lesser known vegetables. A part from being a rich source of micronutrients and vitamins the leafy vegetables are also said to be a good source of antioxidants. Leafy vegetables contains number of phytochemicals which help to protect the cells from oxidative damage induced by free radicals and thereby help to reduce the oxidative stress (Wada and Ou 2002) and thereby play a role in health management, especially...
lowering risk of chronic human ailments such as cancer, cardiovascular disease and other age related disorders. (Vanoppe et al., 1994) [14]. Some researchers have also enumerated the traditional uses of these leafy vegetables plants along with some of their nutritional properties (Kumari and Kumar 2001; Thakur, Kumar and Kumar 2012; Sharma and Rawal 2013) [9, 13]. Keeping these facts in view, attempts have been made to survey the selected districts of Jharkhand to assess the availability and extent of consumption of these lesser known leafy vegetables among the tribal people of Jharkhand. Besides, biochemical analysis of these underutilized leafy vegetables including antioxidant potential and nutritive value has also been done to establish the nutritional and therapeutic authenticity of lesser known vegetables.

**Material and Methods**

The study was conducted between December to March and June 2017, in two districts (Ranchi and Kunti) of Jharkhand state in Eastern India and 29 villages also 3 blocks (Namkum, Bundu, Piska nagdhi). The area lies between 85.0-55.6° latitude and 22.9-23.5° longitude. The choice of study sites was based on the prevalence of all tribes in area, and also the forest cover, to allow for collection of the maximum number of locally consumed species. The selected communities had cultivated and consumed leafy vegetables for a long time, but had not fully exploited the plants economic potential. The tribal hamlets and forest pockets were first visited to collect a broad range of information on the habit, habitat and growth season of traditional vegetables and their medicinal values. Personnel who spoke the local language and had worked for nongovernmental organizations in the area assisted the author. The local people were informed about the study and cooperated in the documentation of their vegetables and their medicinal uses. Past literature on the local use of traditional vegetables was reviewed and questions to ask prepared. Interviews were conducted in 10 villages and local markets with 70 people: elderwomen, elder men, and people working in agriculture, and those having extensive knowledge of local vegetables and also about particular species and their medicinal uses in different disease. Plant specimens were collected with the informants from home gardens, cultivated land, forests, and local markets. The plants were photographed, pressed and dried for identification. The vegetables were identified using the classical reference on indigenous crops by Haines (1921-25). The plants were listed alphabetically, and entries included the botanical names, family, local names, parts consumed or used. Vegetables sold by tribal people in rural (Kunti), peri-urban (Namkum) and urban markets (Ranchi) also were recorded during different season of the year. A list of reported vegetables was prepared and checked with informants to ensure that no locally used leafy vegetables were missing. Samples of 26 potential species of these underutilized leafy vegetables were also collected from the markets and were subjected to biochemical analysis. Antioxidant activity and nutritive properties including vitamin C (ascorbic acid) and minerals (macromineral i.e. Ca, P, Mg, K, S and micro minerals i.e. Fe, Zn and Mn of these underutilized leafy vegetables were analyzed.

- **Antioxidant Activity:** Antioxidant activity of fresh leafy vegetables samples were measured in the form of 2, 2-diphenyl -1-picyrhylhydrazyl (DPPH) radical scavenging ability (Kang and Saltiest 2002). The assay is based on the reduction of absorbance at 517nm. The decrease in absorbance with sample addition was used for calculation of antioxidant activity. A standard curve using different concentrations of ascorbic acid (20-100 µg/ml) was also developed and the result were expressed as µg ascorbic acid equivalent antioxidant capacity (AAE)/100g.

- **Ascorbic Acid (Vitamin C):** Ascorbic acid was determined from fresh sample by volumetric method using 2, 6-dichlorophenol indophenols dye, which turns pink in acid solution (A.O.A.C.1990) [11]. Results were expressed in mg of ascorbic acid per 100g of fresh weight.

- **Minerals Estimation:** For determining mineral content, the leaves or tender shoots or flower were washed initially by tap water followed by dilute hydrochloric acid (0.005) and finally with double distilled water. The leafy sample were them dried in air oven at a temperature of 65±5°C for 24 hours, ground and passed through an 80-mesh sieve (180 µm). Dried sample (1g) were digested with diacid mixture (HNO₃:HClO₄, 9:1). After digestion and extraction of samples,

- **Total P (Phosphorous)** was determined using the vanadomolybdophosphoric acid yellow -colour method (Jackson 1973) [8].
- **Total K (Potassium)** was determined with the flame photometric method (Jackson 1973) [8].
- **Total S (Sulphur)** was determined with the Gum acacia and barium chloride spectrophotometric method (Hesse1971).
- **Water soluble Ca and Mg** were determined by the versanate method (Hesse 1971).
- **Water soluble Fe, Mn, Zn** were measured with an atomic absorption spectrophotometer (AAAnalyst 100, Perkin Elmer, Norwalk, CT, USA).

**Statistical analysis**

Standard Deviation (S.D) was calculated for antioxidant activity, ascorbic acid content and tannin. Whereas, the data obtained on minerals content were subjected to statistical analysis of variance (ANOVA) technique using completely randomized design (CRD).

**Result and discussion**

In the present study, twenty six species of local underutilized leafy vegetables consumed by tribals of Jharkhand were identified through market surveys and villages. During market survey it was found that these leafy vegetables are sold in two forms in the village markets viz. fresh and dried form. Most of these local leafy vegetables are available during winter season, when these were collected and sold in fresh form in the local markets, while the surplus of them were dried and powdered at home and were sold throughout the year in dried form, especially during the lean season i.e in summer. Some of the underutilized leafy vegetables are cultivated while others grow wild either in agricultural fields, wasteland or forests area. These underutilized leafy vegetables can be obtained from different plant types, herbs, shrub, trees or creepers. The parts most commonly consumed are leaves, but tender shoots, buds, flowers, flower buds are also eaten. The information on, botanical names, local name, habitat, habit,
parts consumed are given in Table 1. The availability of leafy vegetables in market *Amaranthus viridis* (Gandhari) was found highest in quantity in the market followed by *Centella asiatica* (Beng), *Hygrophila polysperma* (Muchari), *Polygonum plebeium* (Chemti), *Marsilea minuta* (Chatta saag), *Crotalaria juncea* (Sanai phool) etc. Besides these, there are also few other leafy vegetables which are not found in local markets but rural people collect them for their surroundings and consume them on daily basis, few of these are *Oxalis corniculata* (Netho), *Ficus geniculata* (Putkal), *Colocasia esculenta* (Kudrum phool, patta), *Hibiscus sabdariffa* (Kudrum phool, patta), *Portulaca oleracea* (Golgola).

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Botanical Name</th>
<th>Family</th>
<th>Local Name</th>
<th>Habit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Amaranthus viridis</em></td>
<td>Amaranthaceae</td>
<td>Gandhari saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>2.</td>
<td><em>Alternanthera sessilis</em></td>
<td>Amaranthaceae</td>
<td>Garundi saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>3.</td>
<td><em>Antidesma diandrum</em></td>
<td>Euphorbiaceae</td>
<td>Matha saag</td>
<td>Tree</td>
</tr>
<tr>
<td>4.</td>
<td><em>Bauhinia purpuria(Leaf)</em></td>
<td>Caesalpiniaceae</td>
<td>Koinar phool</td>
<td>Tree</td>
</tr>
<tr>
<td>5.</td>
<td><em>Bauhinia purpuria(Leaf)</em></td>
<td>Caesalpiniaceae</td>
<td>Koinar saag</td>
<td>Tree</td>
</tr>
<tr>
<td>6.</td>
<td><em>Centella asiatica</em></td>
<td>Apiaceae</td>
<td>Beng saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>7.</td>
<td><em>Crotalaria juncea</em></td>
<td>Fabaceae</td>
<td>Sanai phool</td>
<td>Herb</td>
</tr>
<tr>
<td>8.</td>
<td><em>Cassia tora</em></td>
<td>Fabaceae</td>
<td>Chakodh saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>9.</td>
<td><em>Colocasia esculenta</em></td>
<td>Araceae</td>
<td>Kachu saag</td>
<td>Herb</td>
</tr>
<tr>
<td>10.</td>
<td><em>Euphorbia hirta</em></td>
<td>Euphorbiaceae</td>
<td>Dudi saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>11.</td>
<td><em>Ficus geneculata</em></td>
<td>Moraceae</td>
<td>Putkal saag</td>
<td>Tree</td>
</tr>
<tr>
<td>12.</td>
<td><em>Hygrophila polysperma</em></td>
<td>Acanthaceae</td>
<td>Muchari saag</td>
<td>Waterweed</td>
</tr>
<tr>
<td>13.</td>
<td><em>Hibiscus sabdariffla(leaf)</em></td>
<td>Malvaceae</td>
<td>Kudrum phool</td>
<td>Herb</td>
</tr>
<tr>
<td>14.</td>
<td><em>Hibiscus sabdariffla(flower)</em></td>
<td>Malvaceae</td>
<td>Kudrum phool</td>
<td>Herb</td>
</tr>
<tr>
<td>15.</td>
<td><em>Indigophera tinctoria</em></td>
<td>Fabaceae</td>
<td>Jhirul phool</td>
<td>Tree</td>
</tr>
<tr>
<td>16.</td>
<td><em>Ipomea batatas</em></td>
<td>Convolvulaceae</td>
<td>Kanda saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>17.</td>
<td><em>Moringa oleifera(leaf)</em></td>
<td>Moringaceae</td>
<td>Sutti saag</td>
<td>Tree</td>
</tr>
<tr>
<td>18.</td>
<td><em>Moringa oleifera(flower)</em></td>
<td>Moringaceae</td>
<td>Sutti phool</td>
<td>Tree</td>
</tr>
<tr>
<td>19.</td>
<td><em>Marsilea minuta</em></td>
<td>Marsileaceae</td>
<td>Chatta saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>20.</td>
<td><em>Oxalis corniculata</em></td>
<td>Oxalidaceae</td>
<td>Netho saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>21.</td>
<td><em>Oxalis articulata</em></td>
<td>Oxalidaceae</td>
<td>Netho (khatta)saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>22.</td>
<td><em>Oxybasis rubra</em></td>
<td>Amaranthaceae</td>
<td>Jungli bathua</td>
<td>Herb</td>
</tr>
<tr>
<td>23.</td>
<td><em>Polygonum plebeium</em></td>
<td>Polygoraceae</td>
<td>Chemti saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>24.</td>
<td><em>Portulaca oleracea</em></td>
<td>Portulacaceae</td>
<td>Golgola saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>25.</td>
<td><em>Trianthema portulacastrum</em></td>
<td>Aizoaceae</td>
<td>Khapra saag</td>
<td>Shrub</td>
</tr>
<tr>
<td>26.</td>
<td><em>Vangueria spinosus</em></td>
<td>Rubiaceae</td>
<td>Katai saag</td>
<td>Tree</td>
</tr>
</tbody>
</table>
Antioxidant activity
The antioxidant activities (mgAEAC/100g) of twenty six underutilized leafy vegetables were analysed and have been shown in Table 2. Antioxidant activities of these leafy vegetables in the range of variation (1783.33 to 5200 mgAEAC/100g). The total antioxidant found maximum in Colocasia esculenta (5200.00 mg AEAC/100g) followed by Crotalaria juncea (4708.33 mg AEAC/100g), Bauhinia purpuria (flower) (4100.00 mg AEAC/100g), while minimum was in Oxalis corniculata (1783.33 mg AEAC/100g) amongst the leafy vegetables analyzed. The high antioxidant activity of these wild leafy vegetables may be responsible for their wide use in the diet of the tribals and may provide a source of dietary antioxidants (Sahu, Kar and Routray 2013) [11].

Table 2: Total antioxidant of greeny leafy vegetables used by the tribes of Jharkhand, India.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Total antioxidant mg AEAC/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthus viridis</td>
<td>3525.00</td>
</tr>
<tr>
<td>Alternanthera sessilis</td>
<td>1100.00</td>
</tr>
<tr>
<td>Antidesma diandrum</td>
<td>3400.00</td>
</tr>
<tr>
<td>Bauhinia purpuria(Leaf)</td>
<td>4100.00</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>958.33</td>
</tr>
<tr>
<td>Crotalaria juncea</td>
<td>4708.33</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>3733.33</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>5200.00</td>
</tr>
<tr>
<td>Euphorbia hirta</td>
<td>2716.67</td>
</tr>
<tr>
<td>Ficus geniculata</td>
<td>4000.00</td>
</tr>
<tr>
<td>Hygrophila polysperma</td>
<td>3758.33</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
<td>341.67</td>
</tr>
<tr>
<td>Indigophora tinctoria</td>
<td>2941.67</td>
</tr>
<tr>
<td>Ipomea batatas</td>
<td>3558.33</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>4083.33</td>
</tr>
<tr>
<td>Moringa oleifera(flower)</td>
<td>4058.33</td>
</tr>
<tr>
<td>Marsilea minuta</td>
<td>991.67</td>
</tr>
<tr>
<td>Oxalis corniculata</td>
<td>1783.33</td>
</tr>
<tr>
<td>Oxalis articulate</td>
<td>2575.00</td>
</tr>
<tr>
<td>Oxybasis rubra</td>
<td>2576.00</td>
</tr>
<tr>
<td>Polygonum plebeian</td>
<td>2576.00</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>2580.00</td>
</tr>
<tr>
<td>Trianthema portulacastrum</td>
<td>2582.00</td>
</tr>
<tr>
<td>Vangueria spinosus</td>
<td>2584.00</td>
</tr>
<tr>
<td>Mean</td>
<td>2833.65</td>
</tr>
<tr>
<td>F- test</td>
<td>S</td>
</tr>
<tr>
<td>S. Ed. (±)</td>
<td>446.442</td>
</tr>
<tr>
<td>C. D. (0.05%)</td>
<td>946.458</td>
</tr>
</tbody>
</table>

Ascorbic acid (Vitamin C)
The ascorbic acid content (mg/100g) of twenty six potential underutilized leafy vegetables of Jharkhand has been shown in Table 3. The ascorbic acid content of these leafy vegetables range of variation (23.33 to 723.67 mg/100g). The ascorbic acid content found maximum in Amaranthus viridis (723.67 mg/100g) followed by Alternanthera sessilis (548.67 mg/100g), Marsilea minuta (531.33 mg/100g), while
minimum was found in *Euphorbia hirta* (23.33 mg/100g). As in another study the range of vitamin C content (10.19 to 211.20 mg/100g) has been reported by other researchers also in 38 species of tropical leafy vegetables (Ogunlesi et al. 2010) [10].

**Table 3:** Ascorbic acid mg/100g of greeny leafy vegetables used by the tribes of Jharkhand, India.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Ascorbic acid mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthus viridis</td>
<td>723.67</td>
</tr>
<tr>
<td>Alternanthera sessilis</td>
<td>548.67</td>
</tr>
<tr>
<td>Antidesma diandrum</td>
<td>437.67</td>
</tr>
<tr>
<td>Bauhinia purpuria(Leaf)</td>
<td>146.00</td>
</tr>
<tr>
<td>Bauhinia purpuria(Leaf)</td>
<td>52.67</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>41.00</td>
</tr>
<tr>
<td>Crotalaria juncea</td>
<td>35.00</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>210.00</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>64.33</td>
</tr>
<tr>
<td>Euphorbia hirta</td>
<td>23.33</td>
</tr>
<tr>
<td>Ficus geniculata</td>
<td>146.00</td>
</tr>
<tr>
<td>Hygrophila polyparmera</td>
<td>70.33</td>
</tr>
<tr>
<td>Hibiscus sabdariajf(leaf)</td>
<td>58.33</td>
</tr>
<tr>
<td>Hibiscus sabdariajf(flower)</td>
<td>169.33</td>
</tr>
<tr>
<td>Indigophora tinctoria</td>
<td>47.00</td>
</tr>
<tr>
<td>Ipomea batatas</td>
<td>146.00</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>41.00</td>
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<tr>
<td>Moringa oleifera(flower)</td>
<td>40.67</td>
</tr>
<tr>
<td>Marsilea minuta</td>
<td>531.33</td>
</tr>
<tr>
<td>Oxalis corniculata</td>
<td>181.33</td>
</tr>
<tr>
<td>Oxalis articulata</td>
<td>58.33</td>
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<td>Oxysbasis rubra</td>
<td>79.65</td>
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<tr>
<td>Polygonum plebeium</td>
<td>71.79</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>77.71</td>
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<tr>
<td>Triandetha torulacastrum</td>
<td>83.12</td>
</tr>
<tr>
<td>Vangueria spinosa</td>
<td>39.81</td>
</tr>
<tr>
<td>Mean</td>
<td>160.70</td>
</tr>
<tr>
<td>F-test</td>
<td>S</td>
</tr>
<tr>
<td>S. Ed. (±)</td>
<td>60.118</td>
</tr>
<tr>
<td>C. D. (0.05%)</td>
<td>127.451</td>
</tr>
</tbody>
</table>

**Minerals content (Micronutrients and macronutrients)**

Micronutrients (mg/100g) of potential underutilized leafy vegetables of Jharkhand including both macrominerals viz, Calcium (Ca), Phosphorous (P), Magnesium (Mg), Potassium (K) and Sulphur (S) and micronminerals viz, Iron (Fe), Zinc (Zn) and Manganese (Mn) has been shown in Table 4. Calcium and Phosphorous are important for growth and healthy maintenance of bones, teeth, muscles, and blood (Akubugo et al. 2007) [11].

Calcium content in all leafy vegetables analyzed range of variation (4.46 to 90.53 mg/100g) has been shown in Table 4. The maximum calcium content was found in *Vangueria spinosa* (90.53 mg/100g) followed by *Marsilea minuta* (80.35 mg/100g). *Ipomea batatas* (71.48 mg/100g), while the minimum calcium content was found in *Antidesma diandrum* (4.46 mg/100g). These values are higher than the values reported for eight green leafy vegetables grown in South-eastern, Nigeria such as *Ficus capensis, Solanum melongena, Moringa oleifera* etc. (Achikanu et al. 2015) [12]. Thus, results have been reported in six non-conventional leafy vegetables of Nigeria, where *Moringa oleifera, Amaranthus spinosus, and Adansonia digitata* contained comparatively higher amount of calcium (2040.6 mg/100g, 968.7 mg/100g, and 1824.6 mg/100g, respectively) (Barminas, Charles and Emmanuel 1998) [13].

Phosphorous content range varied from (3.76 to 19.79 mg/100g) has been shown in Table 4. The maximum phosphorous content was found in *Oxalis corniculata* (19.79 mg/100g) followed by *Euphorbia hirta* (19.29 mg/100g), *Hibiscus sabdariffa* (19.09 mg/100g), while minimum phosphorous content was found in *Bauhinia purpuria* (3.76 mg/100g).

Magnesium content was ranged from (2.98 to 90.74 mg/100g) has been shown in Table 4. The maximum magnesium content was found in *Vangueria spinosa* (90.74 mg/100g) followed by *Ficus geniculata* (41.11 mg/100g), *Hygrophila polyparmera* (40.46 mg/100g), while the minimum magnesium content was found in *Alternanthera sessilis* (2.98 mg/100g).

As in another study, *A. spinosa* has been reported to contain the highest amount of magnesium (912.4 mg/100g) amongst six non-conventional leafy vegetables of Nigeria (Barminas et al. 1998) [14]. Dietary deficiency of magnesium which is linked with ischemic heart diseases could be prevented by the regular consumption of these vegetables as all these vegetables are good source of magnesium.

The potassium content of the leafy vegetables range varied from (0.68 to 8.19 mg/100g) has been shown in Table 4. The maximum potassium content was found in *Polygonum plebeium* (8.19 mg/100g) followed by *Hygrophila polyparmera* (6.80 mg/100g), *Ficus geniculata* (6.33 mg/100g), while the minimum potassium content was found in *Ipomea batatas* (0.68 mg/100g). In another investigation, *Centella asiatica* has been found to contain the highest potassium concentration amongst four wild leafy vegetables of South Africa (Afolayan and Jimoh 2009) [15]. These indigenous vegetables could therefore meet the daily requirements of potassium for an adult and be useful in the management of hypertension and other cardiovascular diseases (Arlington et al. 1992) [16].

The sulphur content of leafy vegetables analyzed varied from (0.01 to 2.16 mg/100g) has been shown in Table 4. The maximum sulphur content was found in *Ficus geniculata* (2.16 mg/100g). *Oxalis corniculata* (13.36 mg/100g), while minimum was found in *Antidesma diandrum* (0.01 mg/100g). Iron content in the local underutilized leafy vegetables in the present study varied from (0.11 to 1.73 mg/100g) has been shown in Table 5. The maximum iron content was found in *Centella asiatica* (1.73 mg/100g) followed by *Ficus geniculata* (1.33 mg/100g), *Vangueria spinosa* (1.27 mg/100g), while the minimum content was found in *Antidesma diandrum* (0.11 mg/100g) and thus, may help to overcome some of the nutritional problems associated with iron deficiency. However, a comparatively higher range of iron (2.2 to 19.9 mg/g) has been reported in fifteen species of less known wild leafy vegetables of Dumka district of Jharkhand (Thakur et al. 2012) [13].

Zinc content in the present investigation varied amongst leafy vegetables analysed from (0.02 to 0.24 mg/100g) has been shown in Table 5. The maximum zinc content was found in *Vangueria spinosa* (0.24 mg/100g) followed by *Moreinga oleifera* (leaf) (0.23 mg/100g), *Bauhinia purpuria* (leaf) (0.14 mg/100g), while the minimum was found in *Alternanthera sessilis* (0.02 mg/100g). These values are higher as compared to the comparatively higher levels of zinc content (0.3 to 1.2 mg/100g) reported in twenty one wild vegetables traditionally consumed in North-East India (Saikia and Deka 2013). The Manganese content of these underutilized leafy vegetable varied from (0.02 mg/100g) has been shown in Table 5. The maximum Manganese content was found in *Moringa oleifera* (leaf) (1.89 mg/100g), *Euphorbia hirta* (leaf) (1.87 mg/100g), *Hibiscus sabdariffa* (leaf) (1.87 mg/100g), while minimum was found in *Antidesma diandrum* (0.33 mg/100g). These values...
are lower as compared to those reported in fifteen species of less known wild leafy vegetables of Dumka district of Jharkhand (0.29 to 17.9 mg/100g) (Thakur et al. 2012)\(^\text{[13]}\).

### Table 4: Macronutrient of greeny leafy vegetables used by the tribes of Jharkhand, India.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Calcium mg/100g</th>
<th>Magnesium mg/100g</th>
<th>Phosphorus mg/100g</th>
<th>Potassium mg/100g</th>
<th>Sulphur mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthus viridis</td>
<td>19.65</td>
<td>10.85</td>
<td>6.72</td>
<td>3.02</td>
<td>4.77</td>
</tr>
<tr>
<td>Alternanthera sessilis</td>
<td>8.98</td>
<td>2.98</td>
<td>3.89</td>
<td>1.56</td>
<td>2.84</td>
</tr>
<tr>
<td>Antidesma diandraum</td>
<td>4.46</td>
<td>4.51</td>
<td>3.76</td>
<td>1.09</td>
<td>2.01</td>
</tr>
<tr>
<td>Bauhinia purpurea(Leaf)</td>
<td>4.84</td>
<td>10.79</td>
<td>6.08</td>
<td>1.47</td>
<td>3.11</td>
</tr>
<tr>
<td>Bauhinia purpurea(Leaf)</td>
<td>17.91</td>
<td>16.04</td>
<td>8.97</td>
<td>3.85</td>
<td>5.13</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>30.18</td>
<td>12.97</td>
<td>11.96</td>
<td>2.98</td>
<td>6.11</td>
</tr>
<tr>
<td>Crotalaria juncea</td>
<td>27.81</td>
<td>14.17</td>
<td>12.16</td>
<td>3.79</td>
<td>7.90</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>64.44</td>
<td>5.29</td>
<td>11.15</td>
<td>2.49</td>
<td>7.47</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>28.77</td>
<td>16.59</td>
<td>17.38</td>
<td>5.65</td>
<td>10.00</td>
</tr>
<tr>
<td>Electrophorbia hirta</td>
<td>44.88</td>
<td>9.77</td>
<td>19.29</td>
<td>3.00</td>
<td>7.96</td>
</tr>
<tr>
<td>Ficus genericulata</td>
<td>27.82</td>
<td>41.11</td>
<td>13.32</td>
<td>6.33</td>
<td>13.36</td>
</tr>
<tr>
<td>Hygrophila pulexasperma</td>
<td>40.66</td>
<td>40.46</td>
<td>11.51</td>
<td>6.80</td>
<td>7.01</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
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<td>14.04</td>
<td>8.97</td>
<td>4.02</td>
<td>6.11</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
<td>22.91</td>
<td>12.36</td>
<td>19.09</td>
<td>3.73</td>
<td>5.25</td>
</tr>
<tr>
<td>Indigophora tinctoria</td>
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<td>22.10</td>
<td>11.00</td>
<td>7.91</td>
<td>9.96</td>
</tr>
<tr>
<td>Ipomea batatas</td>
<td>71.48</td>
<td>36.38</td>
<td>9.75</td>
<td>0.68</td>
<td>7.33</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>24.47</td>
<td>20.42</td>
<td>5.59</td>
<td>5.42</td>
<td>7.93</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>5.92</td>
<td>7.29</td>
<td>9.38</td>
<td>1.99</td>
<td>3.34</td>
</tr>
<tr>
<td>Maresia minuta</td>
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<td>38.33</td>
<td>10.13</td>
<td>6.14</td>
<td>5.67</td>
</tr>
<tr>
<td>Oxalis corniculata</td>
<td>36.97</td>
<td>6.36</td>
<td>19.79</td>
<td>2.34</td>
<td>6.28</td>
</tr>
<tr>
<td>Oxalis articulata</td>
<td>24.53</td>
<td>23.40</td>
<td>12.92</td>
<td>5.14</td>
<td>12.90</td>
</tr>
<tr>
<td>Oxysbasis rubra</td>
<td>18.97</td>
<td>15.09</td>
<td>13.80</td>
<td>3.83</td>
<td>9.58</td>
</tr>
<tr>
<td>Polygonum plebeem</td>
<td>27.44</td>
<td>17.73</td>
<td>10.13</td>
<td>8.19</td>
<td>11.37</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>14.20</td>
<td>12.95</td>
<td>6.50</td>
<td>4.33</td>
<td>8.58</td>
</tr>
<tr>
<td>Trianthema portulacastrum</td>
<td>6.20</td>
<td>11.25</td>
<td>12.83</td>
<td>2.91</td>
<td>3.76</td>
</tr>
<tr>
<td>Vangueria spinosus</td>
<td>90.53</td>
<td>90.74</td>
<td>11.72</td>
<td>4.95</td>
<td>7.60</td>
</tr>
<tr>
<td>Mean</td>
<td>30.99</td>
<td>20.47</td>
<td>11.07</td>
<td>3.98</td>
<td>7.06</td>
</tr>
<tr>
<td>F- test</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>S.Ed. (±)</td>
<td>9.990</td>
<td>3.235</td>
<td>0.754</td>
<td>0.708</td>
<td>0.195</td>
</tr>
<tr>
<td>C. D. (0.05%)</td>
<td>21.179</td>
<td>6.858</td>
<td>1.598</td>
<td>1.500</td>
<td>0.414</td>
</tr>
</tbody>
</table>

### Table 5: Micronutrient of greeny leafy vegetables used by the tribes of Jharkhand, India.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Fe content mg/100g</th>
<th>Mn content mg/100g</th>
<th>Zn content mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthus viridis</td>
<td>0.67</td>
<td>0.18</td>
<td>0.05</td>
</tr>
<tr>
<td>Alternanthera sessilis</td>
<td>0.14</td>
<td>0.22</td>
<td>0.02</td>
</tr>
<tr>
<td>Antidesma diandraum</td>
<td>0.11</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Bauhinia purpurea(Flower)</td>
<td>0.11</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Bauhinia purpurea(Leaf)</td>
<td>0.53</td>
<td>0.57</td>
<td>0.14</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>1.73</td>
<td>0.30</td>
<td>0.13</td>
</tr>
<tr>
<td>Crotalaria juncea</td>
<td>0.81</td>
<td>0.44</td>
<td>0.06</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>0.28</td>
<td>0.14</td>
<td>0.08</td>
</tr>
<tr>
<td>Colocasia esculenta</td>
<td>0.32</td>
<td>0.09</td>
<td>0.14</td>
</tr>
<tr>
<td>Electrophorbia hirta</td>
<td>0.97</td>
<td>0.29</td>
<td>0.07</td>
</tr>
<tr>
<td>Ficus genericulata</td>
<td>1.33</td>
<td>0.99</td>
<td>0.11</td>
</tr>
<tr>
<td>Hygrophila pulexasperma</td>
<td>1.03</td>
<td>0.25</td>
<td>0.12</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
<td>0.73</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
<td>0.58</td>
<td>0.15</td>
<td>0.07</td>
</tr>
<tr>
<td>Indigophora tinctoria</td>
<td>0.77</td>
<td>0.68</td>
<td>0.10</td>
</tr>
<tr>
<td>Ipomea batatas</td>
<td>0.90</td>
<td>0.13</td>
<td>0.04</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>1.21</td>
<td>1.89</td>
<td>0.23</td>
</tr>
<tr>
<td>Moringa oleifera(leaf)</td>
<td>0.45</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Maresia minuta</td>
<td>0.46</td>
<td>0.17</td>
<td>0.13</td>
</tr>
<tr>
<td>Oxalis corniculata</td>
<td>0.30</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Oxalis articulata</td>
<td>0.77</td>
<td>0.33</td>
<td>0.11</td>
</tr>
<tr>
<td>Oxysbasis rubra</td>
<td>0.77</td>
<td>0.22</td>
<td>0.06</td>
</tr>
<tr>
<td>Polygonum plebeem</td>
<td>1.18</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>Portulaca oleracea</td>
<td>0.15</td>
<td>0.14</td>
<td>0.07</td>
</tr>
<tr>
<td>Trianthema portulacastrum</td>
<td>0.36</td>
<td>0.13</td>
<td>0.07</td>
</tr>
<tr>
<td>Vangueria spinosus</td>
<td>1.27</td>
<td>0.26</td>
<td>0.24</td>
</tr>
<tr>
<td>Mean</td>
<td>0.69</td>
<td>0.31</td>
<td>0.09</td>
</tr>
<tr>
<td>F- test</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>S.Ed. (±)</td>
<td>0.183</td>
<td>0.073</td>
<td>0.008</td>
</tr>
<tr>
<td>C. D. (0.05%)</td>
<td>0.388</td>
<td>0.154</td>
<td>0.017</td>
</tr>
</tbody>
</table>
Tannin Content

The tannin content (%) of twenty six underutilized leafy vegetables were analysed and have been shown in Table 4.1.6. The tannin content of these leafy vegetables in the range of variation (0.07 to 0.46%). The tannin content was found maximum in Ficus geniculata (0.46%) followed by Moringa oleifera (leaf) (0.45%), Vangueria spinosa (0.42%), while minimum was found in Antidesma diandrum (0.07%) amongst the leafy vegetables analyzed. As in another study the range of ash content was found higher that has been reported by the other researcher also in eight species of underutilized vegetables. (Saha et al; 2015). [13].

Table 6: Tannin content present in underutilized leafy vegetables consumed by the local tribes of Jharkhand, India.

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Tannin (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranthus viridis</td>
<td>0.19</td>
</tr>
<tr>
<td>Alternanthera sessilis</td>
<td>0.09</td>
</tr>
<tr>
<td>Antidesma diandrum</td>
<td>0.07</td>
</tr>
<tr>
<td>Bauhinia variegata(Leaf)</td>
<td>0.12</td>
</tr>
<tr>
<td>Bauhinia variegata(Leaf)</td>
<td>0.17</td>
</tr>
<tr>
<td>Centella asiatica</td>
<td>0.21</td>
</tr>
<tr>
<td>Crotalaria juncea</td>
<td>0.36</td>
</tr>
<tr>
<td>Cassia tora</td>
<td>0.23</td>
</tr>
<tr>
<td>Colocassia esculenta</td>
<td>0.30</td>
</tr>
<tr>
<td>Euphorbia birta</td>
<td>0.24</td>
</tr>
<tr>
<td>Ficus geniculata</td>
<td>0.46</td>
</tr>
<tr>
<td>Hygrophila polypetala</td>
<td>0.20</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(leaf)</td>
<td>0.20</td>
</tr>
<tr>
<td>Hibiscus sabdariffa(flow)</td>
<td>0.15</td>
</tr>
<tr>
<td>Indigopheratinctoria</td>
<td>0.29</td>
</tr>
<tr>
<td>Ipomeabatastas</td>
<td>0.14</td>
</tr>
<tr>
<td>Moringaoleifera(leaf)</td>
<td>0.45</td>
</tr>
<tr>
<td>Moringaoleifera(flow)</td>
<td>0.24</td>
</tr>
<tr>
<td>Marselia quadrifolia</td>
<td>0.31</td>
</tr>
<tr>
<td>Oxalis corniculata</td>
<td>0.25</td>
</tr>
<tr>
<td>Oxalis articulata</td>
<td>0.20</td>
</tr>
<tr>
<td>Oxybasirubra</td>
<td>0.10</td>
</tr>
<tr>
<td>Polygonamplebeum</td>
<td>0.18</td>
</tr>
<tr>
<td>Portulacooletaceae</td>
<td>0.29</td>
</tr>
<tr>
<td>Trianthemaportulacastrum</td>
<td>0.37</td>
</tr>
<tr>
<td>Vangueria spinosa</td>
<td>0.42</td>
</tr>
<tr>
<td>Mean</td>
<td>0.24</td>
</tr>
<tr>
<td>F- test</td>
<td>5</td>
</tr>
<tr>
<td>S. Ed. (±)</td>
<td>0.055</td>
</tr>
<tr>
<td>C. D. (0.05%)</td>
<td>0.116</td>
</tr>
</tbody>
</table>

Acknowledgement

The authors are thankful to Dr. Anuradha Shrivastava, Food Scientist of ICAR, Ranchi, Jharkhand for her persistent motivation and encouragement and to Dr. Eugenia P. Lal associate professor of SHUATS, Nani, Allahabad, UP. They are indebted to the tribal people of Jharkhand for evolving such a tremendous heritage of traditional wisdom, safeguarding it and sharing it with them. The authors also convey their gratitude to Mr. A K Gupta, Technical Officer, NBPGR, Ranchi for his invaluable technical assistance during this study.

References