Mineral and Anti-Nutrient Content of Common and Uncommon Green Leafy Vegetables Before and After Drying

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Abstract
Green leafy vegetables play an important place in a well-balanced and healthy diet. To determine the mineral and anti-nutrient content of fresh GLV, quantify the change on drying. Two common (Moringa oleifera and Trigonella foenum graecum) and two uncommon (Boerhaavia diffusa and Trianthema portulacastrum) greens were selected. Their ash content ranged from 1.75±0.19 (T. foenum graecum) to 5.24±0.20 g/100g (B. diffusa) in fresh leaves. In dried leaves the ash was between 10.57±0.19 (M. oleifera) and 18.98±0.26 g/100g. (T. portulacastrum). T. foenum graecum had the least iron (3.79±0.2mg), M. oleifera had the highest (4.43±0.16 mg/100g) iron. Phytate content was 2.46±0.13 (T. portulacastrum) to 5.24±0.20 (B. diffusa) mg in fresh leaves. Drying concentrates the nutrients and antinutrient content.

Introduction
Green leafy vegetables are rightly called as “treasure-trove of micronutrients” and these are termed as “poor men’s diet” as they are abundantly available all-round the year. The greens are inexpensive. They are recognized for their wide variation in color, taste, texture, therapeutic value and give an interesting additional touch to the meals. They are rich sources of vitamins such as beta carotene, ascorbic acid, riboflavin, folic acid as well as minerals like iron, calcium, phosphorous etc. The lack of knowledge especially on the nutritive value of these GLV and elaborate cleaning cooking procedure in general are the main drawback in their lower nutritive value. Drying enhances the shelf life, reduces the volume, makes the product easy to store and handle. This study aimed to determine the mineral and anti-nutrient content of fresh GLV, quantify the change of the same on drying.

Methods
Totally four green leafy vegetables (GLV) were selected (Figure 1). Two commonly consumed greens; Murungai keerai (Drumstick leaves- Moringa oleifera) and Venthaya keerai (Fenugreek leaves–Trigonella foenum graecum) and uncommon greens; Mukarattai keerai (Boerhaiva diffusa) and Saravalli (Trianthema portulacastrum) were chosen based on usage and availability.

The selected uncommon GLV were identified, authenticated and certified by the taxonomist at the Botanical Survey of India of Tamilnadu Agricultural University Coimbatore.

The drumstick leaves and fenugreek leaves were procured from the local vegetable market, Coimbatore, India and the uncommon GLV namely Boerhaiva diffusa and Trianthema portulacastrum were procured from the Agricultural farm in Somanur, Tamilnadu, India.

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Results

Edible portion

The edible portion of the fresh green leafy vegetables chosen for the present study ranged widely from 34 (Venthayakeerai) to 72 g (Mukarattai keerai). This indicates that the non-edible portion was highest in Venthayakeerai and least in Mukarattai keerai. While the Murungai keerai’s edible portion was 46 g it was almost one and half times in Saravallai (63 g).

Effect of drying on the weight of the selected green leafy vegetables

Every 100 gram edible portion of green leafy vegetables when dried; showed a drastic reduction in the weight. (Table-1)

<table>
<thead>
<tr>
<th>Name of greens</th>
<th>Weight (g)</th>
<th>% Edible portion</th>
<th>Percentage reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moringa oleifera</td>
<td>100</td>
<td>78.66</td>
<td>78.66</td>
</tr>
<tr>
<td>(Murungai keerai)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trigonella foenum graecum</td>
<td>100</td>
<td>85.51</td>
<td></td>
</tr>
<tr>
<td>(Venthayakeerai)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trianthema protulacastrum</td>
<td>100</td>
<td>85.73</td>
<td></td>
</tr>
<tr>
<td>(Saravallai)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boerhaiva diffusa</td>
<td>100</td>
<td>84.11</td>
<td></td>
</tr>
<tr>
<td>(Mukarattakeerai)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The decrease in weight ranged from 78.66 (Murungai keerai) to 85.73 percent (Saravallai). This result indicates that on an average; more than three fourths of the greens are made up of water/moisture and the GLV have high water holding capacity. Of all the four greens selected Murungai keerai had the least weight reduction compared to the other three greens namely Venthayakeerai, Saravallai and Mukarattai keerai. The decrease in weight of Venthayakeerai and Saravallai was almost the same at 85/86 percent.

Quality parameter of the selected green leafy vegetables

(i) Moisture

It is quite obvious from the below Figure – 4 that, the moisture content of all the four greens (fresh) selected was above 74 percent but below 91 percent. Of the selected greens; the Murungai keerai contained the lowest (74.62±0.16g) moisture, whereas Saravallai had the highest moisture (90.81±0.41 g). It is also clear from the figure that the process of drying, decreased the moisture content to a maximum of 97.3 percent (Saravallai). One hundred grams of edible portion of the above greens, on drying could give only two to six grams of dried powder. The proximate analysis of Moringa oleifera by Offor, Ehiri and Njoku (2014)8, Sodamade, Bolaji and Adeboye (2013)11 and Sengev, Abu and Gernah (2013)12 revealed the moisture content to be 14.8 percent (dry leaves), 9.00mg/100g (leaf protein concentrate) and 6.46 ± 0.01g percent (dry Moringa oleifera powder) respectively, whereas the value (5.93 ±0.26g percent) obtained in the present study for dry Moringa oleifera was lower than the above reported values. Misra and Malaya (2014)13 analyzed twenty one green leafy vegetables and divulged that the moisture content ranged from 69.6 (Tridax procumbens) to 87.3 percent (Celosia argentea). According to Misra and Malaya (2014)13 and Pasricha and Gupta (2014)14, fenugreek leaves contained 83 percent moisture however the present study’s finding is a little higher at 84.72 ±0.3 g percent. Kasuri methi and fenugreek leaves had 6.07 and 5.22 percent (dry leaves) moisture as communicated by Pasricha and Gupta (2014)14, but in the current study; the dried fenugreek leaves’ moisture was slightly higher at 5.72 ±0.13 g percent.
The moisture content of dry Saravallai greens in the present study was 2.44 ±0.23, whereas Madukwe, Ugwuoke and Ezeugu (2013) value of 7.05 ± 0.17 g percent (dry Saravallai greens) and 16 value of 4.92 ±0.05 g/100g (Saravallai dhal powder) are two to three times higher than the present finding.

Similarly the AIA of the dry samples of the same green leafy vegetables also differed significantly (p=0.0004) at five percent level.

(iii) Total minerals content

The ash (Total minerals) may be defined as the inorganic residue from the incineration of organic matter, but its composition will vary depending on the nature of the food ignited and the method of incineration. Table – 2 indicates that Mukarattai keerai contained relatively higher ash (3.63±0.16 g/100g) than the other three green leafy vegetables analyzed but Venthaya keerai had the lowest ash and it was one and a half times lower than that of Mukarattai keerai’s ash content. The total mineral content of Saravallai and Murrungai keerai was more or less the same at 2.48 ±0.27 and 2.87±0.09 g percent. Drying of green leafy vegetables had enhanced the ash content tremendously and it was 268.29 (Murrungai keerai) to 665.32 (Saravallai) percent. Offor, Ehiri and Njoku (2014) and Sodamade, Bolaji and Adeboye (2013) documented the ash content of 3.8 percent (dry leaves) and 6.00mg/100g (leaf protein concentrate) and 5.36 ± 0.01 g percent (dry powder) and 2.3 g percent (fresh) in Moringa oleifera.

Table 2. Ash content of the selected green leafy vegetables

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Moringa oleifera</th>
<th>Trigonella foenum graecum</th>
<th>Trianthema portulacastrum</th>
<th>Boerhaavia diffusa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD g / 100 g</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh</td>
<td>2.87±0.09</td>
<td>1.75±0.19</td>
<td>2.48±0.27</td>
<td>3.63±0.16</td>
</tr>
<tr>
<td>Dry</td>
<td>10.57±0.19</td>
<td>12.30±0.30</td>
<td>18.98±0.26</td>
<td>16.28±0.14</td>
</tr>
<tr>
<td>Percent increase</td>
<td>268.29</td>
<td>602.85</td>
<td>665.32</td>
<td>348.48</td>
</tr>
</tbody>
</table>

On the other hand in the current study the ash content of the fresh and dry Moringa oleifera was 2.87±0.09 and 10.57±0.19 g percent only. Pasricha and Gupta (2014) and Gopalan et al (2007) documented the ash content of fenugreek leaves as 13.36 g percent (dry leaves) and 1.5 (fresh) g percent however in this study; 1.75±0.19 (fresh) and 12.30±0.30 g percent (dry) of ash was obtained for fenugreek leaves.

The ash content of dry Saravallai greens (7.69 ± 0.13 g/100 g) and Saravallai dhal powder (12.3 ±0.2 g/100g) as reported by Madukwe, Ugwuoke and Ezeugu (2013) and Gobi and Narayanan (2015) are one and a half to two and a half times lower than the present finding of 18.98±0.26 g percent.

(iv) Calcium content

Calcium is the most abundant divalent cation. The fresh Murrungai keerai and Mukarattakeerai (Figure-6) had 633.43±0.18 and 577.72±0.14 mg of calcium, whereas the Venthaya keerai (161.60±0.22) and Saravallai’s (156.20±0.24) calcium content was 3.5 to 4 times lower than the above values.
The process of desiccation had enhanced the calcium content enormously and it ranged from 105.31 (Murrunga keeरai) to 484.74 (Venthaya keeरai) percent. Although the fresh Venthya keeरai and Saravallai contained less calcium compared to fresh Murrunga keeरai and Mukaratta keeरai, the level of calcium increase was high in the former two greens than the latter two on dehydration. Navale et al., (2014) 18 had investigated and recorded the quantity of calcium as 395.1063 and 1753 mg/100g in fresh, cabinet and solar dried fenugreek leaves. The present research’s findings of 161.60 ± 0.22 mg percent in fresh and 944.94 ± 0.20 mg percent in dried fenugreek leaves is two and a half and two times lower. Pasricha and Gupta (2014) 14 had found the Calcium content as 10988 µg/g in Methi leaves.

By moisture analyzer drying method the Calcium content of Drumstick, Moringa oleifera was found to be increased 17.12 percent (Venthayakeerai). Madukwe, Ugwuoke and Ezeugwu (2013) B and Gobi and Narayanan (2015) 16 had reported a very low (171.6 ± 5.66 mg/100g) and low (589.33 ± 8.14 mg/100g) calcium content in dry Saravallai greens and Saravallai dhal powder compared to the present finding of 750.91 ± 0.21 mg/100g. No significant difference was present in the calcium content of the selected green leafy vegetables either in the fresh form (p=1.78) or in the dry form (p=9.55) at five percent level.

(v) Iron content

The amount of iron that was present in the selected green leafy vegetables before and after desiccation is disclosed in Table 3. It is quite evident from the above table that there is no wide variation in the iron content of the four fresh green leafy vegetables. It was between 3.79 ±0.2 (Venthayakeerai) to 4.43 ±0.16mg/100g (Murrunga keeरai) Venthya keeरai and Mukaratta keeरai’s iron content were within 3.5 to 4mg/100g. Likewise Murrungai keeरai and Saravallai’s iron content was between 4 to 4.5mg/100g. Parching of the green leafy vegetables had facilitated complete removal of moisture and increase in iron content and the increment was up to 88.12 percent (Venthayakeerai).

The iron content of dry Moringa oleifera powder (8.30 ± 0.01 g percent) as presented by 12, dry Saravallai powder (19.42 ±0.13mg/100g) as given by 16 and Saravallai dhal powder (30.13 ±2.4 mg/100g) as stated by Gobi and Narayanan (2015) 16 are comparatively higher than the current finding.

![Figure 7. Zinc content of the selected green leafy vegetables.](image)

The fresh Venthya keeरai and Mukaratta keeरai had the same amount 0.7 ±0.22 mg of zinc, while the Murrungai keeरai had 0.65 ±0.21 mg, Saravallai had still a lower (0.51±0.13) zinc content. The process of desiccation had enhanced the amount of zinc up to 42.85 percent (Venthayakeerai). Mukaratta keeरai can be ranked next with 35.71 percent increase in zinc content. Improvement in the quantity of zinc was more similar in Murrunga keeरai and Saravallai (15.38 and 17.64). The least increase was observed in Murrunga keeरai. Pasricha and Gupta’s (2014) 16 finding of 49.6 µg/g zinc in dry fenugreek leaves is four times higher than the current study’s finding. Gobi and Narayanan (2015) 16 report of 0.90 ±0.10 mg/100g (Saravallai dhal powder) zinc similar to the present result. Statistical analysis (ANOVA) did not show any significant difference among the Murrungai keeरai, Venthya keeरai, Saravallai and Mukaratta keeरai at five percent level.

(vii) Phytate content

Phytic acid is the major phosphorus storage compound in leafy vegetables and this compound chelates multivalent metal ions such as zinc, calcium and iron, reducing their bioavailability (Champ (2005) 20 and Schlemmer et al (2009) 21. The anti-nutrient inositol (phytate) content was between 2.46±0.13 and 5.24±0.20 mg/100g. Murrungai keeरai and Venthya keeरai’s phytate content was nearer to each other with 4.61±0.20 and 3.88±0.19 mg/100g. Udousore et al (2013) 22 study on four different green leafy vegetables of Nigeria found that the phytate content of fresh green leafy vegetables ranged from 33 to 43 mg/100g. Dried powders of the green leafy vegetables of the current research contained 12.0±0.19 to 132.0±0.10 mg/100g, whereas 17.25 ±0.00 to 86.45 ± 0.10 mg/100 g of phytate. (Amaranthus hybrida, Andasonia digitata, Ceiba pentandra, Hibiscus sabdariffa and Vigna unguiculata) was reported by Patricia et al (2014) 23.

Conclusion

Green leafy vegetables could be sun dried for later use and sun drying concentrates the nutrient as well as the anti-nutrient content of green leafy vegetables.
Acknowledgment

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References


