NUTRITIONAL COMPOSITION OF VALUE ADDED PRODUCTS PREPARED FROM THE UNDERUTILIZED INDIAN SORREL LEAVES (Oxalis Corniculata)

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Abstract
The Indian sorrel leaves also known as Oxalis corniculata or wood sorrel, it is an underutilized plant having so nutritional properties. It is rich in ascorbic acid and act as an anti-ascorbetic for scurvy. In traditional system it is also used as medicine. The study was aimed to formulate and analyze the value added products prepared from the underutilized fresh Indian sorrel leaves. Value added products were analyzed for proximate constituents, minerals and Vitamin C. Results showed that the products were enriched with fresh Indian sorrel leaves are rich in protein, energy, carbohydrate, iron, calcium and Vitamin C. Moisture content was higher in lemon drink (93.68±1.02), on the other hand, iron and calcium content was higher in peanut chutney (44.25±5.79), (60.55±20.58) respectively. Fat, fiber, protein, energy, carbohydrate and Vitamin C content was more in idli (18.78±0.53), (24.17±1.31), (1.26±2.46), (91.26±54.44), (20.06±11.75) and (26.18±3.18) respectively. Therefore it can be concluded that the incorporation of the leaves of Indian sorrel in various food items can improve the nutritional qualities.

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Key words: Nutritional composition, Indian sorrel, Fresh leaves.

INTRODUCTION
Green leafy vegetables occupy an important place among the food crops as these provide adequate amounts of many vitamins and minerals for humans. They are rich source of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorous.[13]

Underutilized green leafy vegetable generally grow in arid, hilly and tribal areas and are rich sources of vitamins and minerals and other nutrients can provide a solution to the problem of malnutrition to a great extent provide the masses are exposed to their nutritional and medicinal values through various extensions strategies. India owns rich bio-diversity of such food crops although few studies have been conducted to document the nutritive value of underutilized foods and information available is quite meager [7].

In recent decades, a resurgence of interest has focused on underutilized plant species for their possible nutritional and medicinal values to broaden the diversity of human diet [15,21]. This is because people today are more concern about the effects of modern agricultural technology and marketing, which only cultivate plant types that have high productivity and consequently caused massive lost of biodiversity. Approximately two-thirds of total dietary energy intake is obtained from twelve domesticated species: eight cereals (barley, maize, millet, rice, rye, sorghum, sugar cane, and wheat) and four tubers (cassava, potato, sweet potato and yam) [22]. Besides the reduction of genetic diversity of plants species in human diets, the high dietary selectivity practice has become another factor that cause difficulty in getting full complement of essential nutrients through daily diet which consequently lead to malnutrition and under-nutrition [23]. Furthermore, most of the foods consumed by people have been “upgraded” to an extreme through refined and modified processes using various food preparation techniques such as cooking, crushing, leaching, and husking that causes inadvertently reduction or removal of certain essential nutrients from the food [24]. On the other hand, increasing research on underutilized vegetables in different regions showed that most of these wild greens have great nutritional values and antioxidant properties, which are comparable to those commercially cultivated vegetables [25,26].
**Oxalis corniculata** is an underutilized and subtropical plant and it is originated in India. The plants have diverse genus and consist of about 900 species. *Oxalis corniculata* is commonly known as creeping wood sorrel. It belongs to the family Oxalidaceae. It is a very popular perennial herb, delicate appearing, low growing and herbaceous plant. The plant is a procumbent herb, stems rooting and having pubescent with apprised hair. Leaves are trifoliate with three heart shaped leaflet. The flowers are yellow in colour. It is distributed as a weed in damp shady places, roadsides, plantations, lawns and nearly all the regions throughout the warmer parts of India.

The leaves of *Oxalis corniculata* are quite edible with a tangy taste, it is well known for its medicinal value and as a good appetizer. In the traditional system of medicine, the whole plant have been employed for treating anaemia, wounds, cancer, piles and skin eruptions. It is used in the treatment of influenza, fever, urinary tract infection, diarrhoea and poisonous snake bites. The plant is a good source of vitamin C and is used as an anti-scouring in the treatment of scurvy [6].

2. MATERIALS AND METHODS

The investigation was conducted in the Department of Foods and Nutrition, Ethelind School of Home Science, Sam Higginbottom Institute of Agriculture, Technology and Sciences (SHIATS), Allahabad.

The details of the materials, experimental procedure and techniques to be adopted during the course of the investigation were as follows:

2.1. Experimental site: The present investigation was carried out in the Nutrition Research Laboratory, Foods and Nutrition, Ethelind School of Home Science, SHIATS, Allahabad.

2.2. Procurement of raw materials: Healthy green leaves of Indian sorrel (*Oxalis corniculata*) required for the experiment was collected from Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. Only the fresh and sound leaves were collected. Those leaves were washed with the help of clean water so as to remove the dirt and other diseases causing organisms.

2.3. Development of Value added food products: Three products were prepared with the incorporation of fresh Indian sorrel leaves namely- peanut chutney, lemon drink, and idli. For each product, the basic recipes (control T0) have three variations T1, T2, T3 respectively where the amount of Indian sorrel leaves were varied.

2.4. Sensory Evaluation: Sensory evaluation of the food products for their acceptability was done by a panel of judges. The panel members were instructed about the product and its characteristics. Panel members were selected based on their performance in initial evaluation trials. Sensory descriptors of the samples were appearance (visual appeal on sight), colour (adequacy of hue and uniformity), aroma (olfactory feeling on inhaling the head space volatiles), taste (response of taste bud on masticating), texture (force to chew and consistency on melting), and overall acceptability (likeness as compared to commercial product) There are eight numbers of judges for the sensory evaluation. The nine point hedonic scale was used for sensory evaluation [1].

2.5. Nutritional Composition of the value added Food products developed by Indian sorrel leaves:

i. Proximate analysis: Chemical estimation of moisture, ash, protein, fat and fibre content was done by AOAC. [2] using standard procedure. Methods describe by AOAC, [2] was used for determination of chemical composition of selected product, this included estimation of moisture, ash, crude fat, protein, crude fiber and carbohydrate was calculated by difference method and energy was estimated by calculation method.


iii. Vitamin C: Vitamin C was estimated using standard procedures [4].

3. RESULTS AND DISCUSSION

Using the fresh leaves of Indian sorrel the three value added products were prepared and to analyze the proximate composition, minerals and Vitamin C content.

3.1. Moisture Content

The moisture content was highest in Lemon Drink (93.68g/100g) and least was found in Peanut chutney (39.35g/100g) (Table 1). The Lemon drink has the highest content of water due to the more water content as it is made by adding water, lemon juice and extract of the leaves of Indian sorrel. Lemon and lime juice promote the release of sodium bicarbonate from the pancreas to support enzyme activity. The high moisture content of these plants give great impact on energy density (amount of energy in a given weight of food (kcal/g)) as water adds substantial weight to the food without adding energy and this may give the consumers a better satiety without increase their energy intake [31].

Gupta and Prakash [16] reported that the moisture content of the fresh *Amaranthus paniculatus* and *Peucedanum graveolens* was 86.5 and 90.4% whereas dehydrated GLV contained 4.9 and 7.4 % respectively. Similar study was also conducted on *Oxalis corniculata* leaves and on some other Nigerian green leafy vegetables [5].

3.2. Ash content

Ash content of the developed products varied from 0.39 to 44.25 g/100g. In case of Peanut chutney it was observed to be maximum not only due to the basic ingredients but also due to incorporation of Indian sorrel leaves which is higher in the mineral content.

Singh et al [17] has been reported that the ash content of the two products namely parantha and dal increased slightly might be due to the replacement of other ingredients with dehydrated bathua leaves.

3.3. Protein content

Protein content of selected products ranged between 0.26 to 1.26 g/100g. Protein content of the sample was highest in *Idli* (1.26g/100g) followed by *Lemon Drink* (0.26g/100g) value of the product. *Idli* has the highest content of protein is because of the addition of pulses. Pulses contain the highest amount of protein.
Table 1 Mean nutrient compositions of the products developed by incorporating Indian sorrel leaves (per 100 g).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture (%)</th>
<th>Ash (g)</th>
<th>Fat (g)</th>
<th>Fiber (g)</th>
<th>Protein (g)</th>
<th>Energy (kcal)</th>
<th>Carbohydrate (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanut chutney</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₀</td>
<td>39.35±6.47</td>
<td>44.25±5.79</td>
<td>7.15±3.27</td>
<td>14.15±2.03</td>
<td>0.57±0.08</td>
<td>74.99±41.06</td>
<td>17.07±4.06</td>
</tr>
<tr>
<td>T₁</td>
<td>51.94±1.34</td>
<td>29.59±2.71</td>
<td>7.97±2.14</td>
<td>16.09±1.79</td>
<td>0.53±0.95</td>
<td>86.44±44.18</td>
<td>19.85±10.47</td>
</tr>
<tr>
<td>T₂</td>
<td>48.47±8.61</td>
<td>30.48±6.66</td>
<td>4.75±1.55</td>
<td>15.46±2.10</td>
<td>0.51±0.86</td>
<td>56.78±23.47</td>
<td>16.47±5.41</td>
</tr>
<tr>
<td>T₃</td>
<td>39.93±11.48</td>
<td>38.25±2.84</td>
<td>6.03±0.57</td>
<td>14.68±1.63</td>
<td>0.57±0.08</td>
<td>76.77±42.87</td>
<td>18.88±10.97</td>
</tr>
</tbody>
</table>

Lemon drink

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture (%)</th>
<th>Ash (g)</th>
<th>Fat (g)</th>
<th>Fiber (g)</th>
<th>Protein (g)</th>
<th>Energy (kcal)</th>
<th>Carbohydrate (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>93.68±1.02</td>
<td>0.64±0.26</td>
<td>-</td>
<td>-</td>
<td>0.38±0.09</td>
<td>51.24±21.12</td>
<td>12.35±5.27</td>
</tr>
<tr>
<td>T₁</td>
<td>91.44±1.97</td>
<td>0.93±0.46</td>
<td>-</td>
<td>-</td>
<td>0.35±0.78</td>
<td>52.25±21.41</td>
<td>13.10±5.01</td>
</tr>
<tr>
<td>T₂</td>
<td>87.96±7.69</td>
<td>1.66±0.73</td>
<td>-</td>
<td>-</td>
<td>0.47±0.06</td>
<td>53.64±19.6</td>
<td>12.86±4.85</td>
</tr>
<tr>
<td>T₃</td>
<td>92.65±1.75</td>
<td>0.68±0.23</td>
<td>-</td>
<td>-</td>
<td>0.26±0.035</td>
<td>33.12±19.5</td>
<td>12.06±2.68</td>
</tr>
</tbody>
</table>

Idli

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture (%)</th>
<th>Ash (g)</th>
<th>Fat (g)</th>
<th>Fiber (g)</th>
<th>Protein (g)</th>
<th>Energy (kcal)</th>
<th>Carbohydrate (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>60.38±14.99</td>
<td>0.39±0.16</td>
<td>18.78±0.53</td>
<td>22.26±3.08</td>
<td>0.75±1.02</td>
<td>88.95±45.67</td>
<td>19.95±11.6</td>
</tr>
<tr>
<td>T₁</td>
<td>55.27±9.73</td>
<td>1.38±0.74</td>
<td>16.11±2.19</td>
<td>21.61±1.50</td>
<td>0.86±1.4</td>
<td>91.26±54.44</td>
<td>20.06±11.75</td>
</tr>
<tr>
<td>T₂</td>
<td>62.33±3.85</td>
<td>1.41±0.69</td>
<td>17.02±1.65</td>
<td>22.52±2.24</td>
<td>0.94±0.95</td>
<td>86.72±44.34</td>
<td>18.78±10.79</td>
</tr>
<tr>
<td>T₃</td>
<td>58.45±12.15</td>
<td>1.49±0.91</td>
<td>13.44±2.06</td>
<td>24.17±1.31</td>
<td>1.26±2.46</td>
<td>89.90±47.68</td>
<td>19.06±10.47</td>
</tr>
</tbody>
</table>

Table 2. Mineral contents of the products prepared by the incorporation of Indian sorrel leaves (per 100 g).

<table>
<thead>
<tr>
<th>Products and Treatments</th>
<th>Peanut chutney</th>
<th>Lemon drink</th>
<th>Idli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (mg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₀</td>
<td>33.37±1.3</td>
<td>30±1.0</td>
<td>36.5±0.2</td>
</tr>
<tr>
<td>T₁</td>
<td>20.78±1.0</td>
<td>14.23±1.0</td>
<td>30±1.0</td>
</tr>
<tr>
<td>T₂</td>
<td>52.05±1.8</td>
<td>46.03±1.8</td>
<td>34.45±1.8</td>
</tr>
<tr>
<td>T₃</td>
<td>60.45±1.8</td>
<td>50.04±1.8</td>
<td>38.41±1.8</td>
</tr>
</tbody>
</table>

| Calcium (mg)            |               |             |      |
| T₀                      | 52.05±1.8      | 30±1.0      | 7.00±0.2 |
| T₁                      | 12.10±1.8      | 12.10±1.8   | 3.64±0.2 |
| T₂                      | 60.45±1.8      | 60.45±1.8   | 10.39±0.2 |
| T₃                      | 11.05±1.8      | 11.05±1.8   | 31.06±0.2 |

Table 3. Vitamin C contents of products prepared by the incorporation of Indian sorrel leaves (per 100 g).

<table>
<thead>
<tr>
<th>Products and Treatments</th>
<th>Peanut chutney</th>
<th>Lemon drink</th>
<th>Idli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C (mg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T₀</td>
<td>16.65±0.2</td>
<td>10.64±0.2</td>
<td>20.2±0.2</td>
</tr>
<tr>
<td>T₁</td>
<td>15.96±0.2</td>
<td>12.04±0.2</td>
<td>22.4±0.2</td>
</tr>
<tr>
<td>T₂</td>
<td>17.49±0.2</td>
<td>13.58±0.2</td>
<td>23.1±0.2</td>
</tr>
<tr>
<td>T₃</td>
<td>17.48±0.2</td>
<td>12.78±0.2</td>
<td>26.18±0.2</td>
</tr>
</tbody>
</table>

The crude protein in the leaves of * Oxalis corniculata* (28%±0.5) was found more than *Ipomoea aquatic* leaves i.e. 17.84%, this investigation was done by Vishwakarma and Dubey [10].

Saha and Dunkwal [18] studied that the higher content of protein in spread instant mix was found in developed (22.64 per cent) than its control sample (16.25 per cent) which might be due to higher protein content of mothbean used as main ingredient in developed sample which is higher in protein content.

3.4. Carbohydrate and Energy content

Carbohydrate content of the developed product was found to be in the range of 12.06 to 20.06 g/100g. *Idli* incorporated with Indian sorrel leaves shows the highest carbohydrate (20.06 g/100g) and lowest was *Lemon drink* (12.06g/100g).

The same study on the content of carbohydrate was also reported by Asbyee-Berko et al. [3] on many types of Nigerian green leafy vegetables. Energy values ranges from 33.12 to 91.26 Kcal/100g. The maximum energy values were observed in *Idli* and peanut chutney which has energy rich ingredients like pulses and rice, and peanut respectively. Similar study was also carried by Sunitha et al., [9] on the selected cereal based preparations.

3.5. Iron content

Robinson [12] reported that, a diet that meets two-thirds of the RDA (Recommended Dietary Allowances) values is considered to be adequate for an individual. Table 2 furnishes the mineral composition of the developed products.

Table 2 shows that iron content was higher in peanut chutney i.e. 60.55±20.58, followed by lemon drink i.e. 40 ± 8.16. The iron content was higher in the peanut chutney was due to the peanut was roasted in the iron pan, as the leaves of Indian sorrel rich in ascorbic acid, hence ascorbic acid enhances the iron absorption.

In this analysis, an outstanding finding was made on iron content in the product developed by Indian sorrel leaves. Similar study was also done by Umar et al [20] on the leaves of *Ipomoea aquatic*. Anaemia serves as a biomarker because lower hemoglobin levels are associated with higher rates of cardiovascular and renal events, Mitka [19].

3.6. Calcium content

Calcium content was observed highest in the Peanut chutney i.e. 69.10 mg/100g and least in *Idli* (31.06 mg/100g) because of peanuts are rich source of minerals like calcium, iron, and Indian sorrel leaves also a good source of calcium. Calcium with the name of “super nutrient” has been proven clinically associated with
reduced risk of various non-communicable diseases such as osteoporosis [30], cardiovascular diseases [18] and it also helps to reduce colorectal cancer risk by promoting the apoptosis in human colorectal epithelium that reduce colorectal neoplasms [27,28]. Few researches have promoted the intake of plant-based diet such as soybean and green leafy vegetable as a source of calcium instead of dairy or animal products. This is because animal protein could increase bone loss and risk of fracture through promoting calcium excretion and acid-base metabolism [29].

3.6. Ascorbic acid content

Table 3 shows that the range of vitamin C in all the prepared products was 10.64 to 26.18 mg/100g. Idli was found to be highest in vitamin C content i.e. 26.18 mg/100g. The difference in the nutrient content in each product is due to the fact that fermentation process increases the ascorbic acid content Srilakshmi [14]. According to the findings of Lui et al. [32], high concentration of ascorbic acid in plant samples might associated with attractive free radical scavenging capacity and health benefit like anti-carcinogenic and anti-atherogenic.

Gupta et al.[33] was also studied the nutritional composition of the fresh Indian sorrel leaves. From the study it was observed that the fresh Indian sorrel leaves are good source of micronutrients and natural antioxidants in alleviating malnutrition problems of local societies especially the rural populace.

CONCLUSION

It is concluded that the incorporation of Indian sorrel leaves in the prepared products increases the nutrient density or nutritional qualities. Peanut Chutney was rich in iron content i.e. 60.55mg/100g, protein, energy and calcium was observed highest in Idli i.e.1.26g/100g, 91.26 kcal/100g and 69.10 mg/100g respectively. Vitamin C content was also highest in Idli i.e. 26.18 mg/100g. This is believed to be a practical food-based approach aimed at combating malnutrition in India and other developing countries.

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REFERENCES


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