Nutrient content of fresh and nutrient retention in cooked *Solanum nigrum* Linn. leaves and green berries

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\textbf{Abstract}

At present, the demand for nutraceuticals in lifestyle diseases is increasing due to its low side effects. Many of the vegetables which we include in the diet itself possess nutraceutical properties besides its culinary purposes. Many such plants are still unfamiliar to the common man due to lack of awareness about their therapeutic potentials. *Solanum nigrum* Linn. is a plant which belongs to the family Solanaceae and possess nutraceutical properties. Nutrient retention of vegetables subjected to different cooking methods varies. The present study aimed to analyse the nutrient content and estimate the percentage of nutrient retention in *Solanum nigrum* Linn. leaves and green berries subjected to different cooking methods. Fresh leaves and green berries were harvested from the green house in which cultivation was done and were cooked by boiling, pressure cooking, steaming, sautéing and microwave. Nutrients in both fresh and cooked leaves and berries were analyzed using standard procedures using Millipore water. The percentage of nutrient retention in each cooked sample was calculated using USDA true retention formula. Findings revealed that among the cooked leaves, the steamed leaves possessed more carbohydrates and proteins while in case of green berries, more crude fibre and carbohydrates was seen. Besides these, a significant amount of iron, calcium, phosphorus and vitamin C contents were present in steamed leaves and green berries when compared with other cooking methods. Similar results were observed in case of percentage of nutrient retention also. From the results, it can be concluded that, steaming is the best method of cooking to retain more nutrients in *Solanum nigrum* Linn. leaves and green berries. Since the fresh leaves and green berries is normally not consumed by humans, steaming may be considered as the best method for human consumption to avail the maximum nutritional and therapeutic benefits of the leaves and green berries.

\textbf{Key Words:} *Solanum nigrum* Linn, Leaves, Green berries, cooking methods, Nutrient content, Nutrient retention

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1. Introduction
Phytonutrients in plant foods are a remedy for various diseases from ancient time onwards. The demand for nutraceuticals in lifestyle diseases is increasing due to its low side effects. Nutraceuticals has led to a novel period of health and medicine which directed food industry as one of the research oriented sectors [1]. Some plants used for culinary purposes exhibit curative benefits towards various diseased conditions due to their nutraceutical potential. The plant family Solanaceae has remarkable role as a food to human and animal poses remedial effect in ethno medical practices and traditional cultures [2]. Solanum nigrum Linn.is a plant which belongs to the family Solanacea and possesses nutraceutical properties. The plant is a broadly used green leafy vegetable and better source of medicinal plant in South East Asia and Africa [3]. Nutrient retention in vegetables subjected to different cooking methods varies. The present study aimed to identify the best method of cooking for Solanum nigrum Linn. leaves and green berries with minimal nutrient loss though the analysis of nutrient content and percentage of nutrient retention.

2. Materials and Methods
2.1 Cultivation of plant
The leaves and green berries of Solanum nigrum Linn. were used for the study. For the authenticity of leaves and berries used for the study, the plant Solanum nigrum Linn. was cultivated in green house and certified by a taxonomist.

2.2 Collection of Solanum nigrum Linn. leaves and green berries
The leaves used for the study were collected between 75-100 days and green berries were collected between 90-120 days after germination. The specimen harvested were cleaned and washed in running tap water and subjected to different methods of cooking namely boiling, steaming, pressure cooking, sauteing and microwave cooking.

2.3 Analysis of nutrient content
Ash content, moisture, crude fibre, carbohydrate, protein, fat, calcium, iron, phosphorus and vitamin C of fresh and different cooked samples of Solanum nigrum Linn. leaves and green berries were analyzed. The analysis was done in triplicate samples with standard procedures recommended by National Institute of Nutrition. The water used for analysis was Millipore (Milli-Q) water, which is the most pure one (deionized) for analysis purposes.

2.4 Calculation of percentage of nutrient retention
The percentage of nutrient retention in cooked Solanum nigrum Linn. leaves and green berries were calculated by USDA True Retention Method Formula [4].

\[
\%TR = \frac{N_c \times G_c}{N_r \times G_r} \times 100
\]

\( TR = \) True Retention, \( N_c = \) Nutrient in cooked food (g), \( G_c = \) Weight of cooked food (g), \( N_r = \) Nutrient in raw food (g), \( G_r = \) Weight of food before cooking (g)

From calculation of percentage of nutrient retention and analysis of nutrient content in different cooked Solanum nigrum Linn. leaves and green berries, the best method of cooking for the same with minimal nutrient loss was identified.

3. Results & Discussion
The results of the study are discussed as follows

3.1 Application of different cooking methods
The leaves and green berries of Solanum nigrum Linn. harvested were subjected to various methods of cooking as boiling, steam cooking, pressure cooking, microwave cooking and sauteing.

A variation in weight of the leaves was observed after application of different methods of cooking, as depicted in Table 1.
Table 1 Weight of Solanum nigrum Linn. leaves and green berries subjected to different methods of cooking

<table>
<thead>
<tr>
<th>Cooking methods</th>
<th>Leaves Before cooking (g)</th>
<th>Leaves After cooking (g)</th>
<th>Green Berries Before cooking (g)</th>
<th>Green Berries After cooking (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling</td>
<td>100</td>
<td>127</td>
<td>100</td>
<td>108</td>
</tr>
<tr>
<td>Steaming</td>
<td>100</td>
<td>117</td>
<td>100</td>
<td>97</td>
</tr>
<tr>
<td>Pressure cooking</td>
<td>100</td>
<td>137</td>
<td>100</td>
<td>110</td>
</tr>
<tr>
<td>Microwave cooking</td>
<td>100</td>
<td>74</td>
<td>100</td>
<td>71</td>
</tr>
<tr>
<td>Sautéing</td>
<td>100</td>
<td>80</td>
<td>100</td>
<td>78</td>
</tr>
</tbody>
</table>

The methods of cooking, boiling, steaming and pressure cooking caused an increase in weight of leaves as 127g, 117g and 137g respectively. Since water is the medium of cooking in these three methods, absorption of moisture during cooking may be the reason for increase of weight upon cooking.

In case of green berries, boiling and pressure cooking made an increase in weight of berries (108g and 110g respectively). But steaming cause a loss of weight as 97g from initial 100g. Steaming sometimes wilt the berries and loss of water content from it in small amount. This may be the reason for loss of weight upon steaming in green berries. Since microwave cooking does not requires any medium of cooking [5], the moisture content in leaves and berries get reduced and hence the weight also get reduced as 74g and 71g respectively.

Sautéing require oil as the medium of cooking and the leaves and berries get shrink and loss moisture content. This causes reduction in weight of leaves and berries upon sauteing. The weight of leaves and berries decreased to 80g and 78g respectively from 100g of fresh sample upon sauteing.

3.2 Nutrient content of Solanum nigrum Linn. leaves

The selected nutrients such as ash, moisture, crude fibre, carbohydrate, protein, fat, iron, calcium, phosphorus and vitamin C were estimated quantitatively for fresh and cooked Solanum nigrum Linn. leaves and green berries.

Table 2 Nutrient content of Solanum nigrum Linn. leaves

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Fresh leaves</th>
<th>Boiled</th>
<th>Steamed</th>
<th>Pressure cooked</th>
<th>Microwave cooked</th>
<th>Sautéed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proximate composition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash (g)</td>
<td>1.67± 0.03</td>
<td>1.12± 0.13</td>
<td>1.30± 0.02</td>
<td><strong>1.39± 0.05</strong></td>
<td>1.23± 0.05</td>
<td>1.32± 0.03</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>84.32± 0.04</td>
<td>87.62± 0.67</td>
<td>86.02± 0.17</td>
<td><strong>89.87± 0.19</strong></td>
<td>72.03± 0.18</td>
<td>68.04± 0.13</td>
</tr>
<tr>
<td>Crude Fibre (g)</td>
<td>1.29± 0.02</td>
<td>1.14± 0.15</td>
<td>1.15± 0.13</td>
<td>1.20± 0.01</td>
<td>1.16± 0.19</td>
<td><strong>1.28± 0.02</strong></td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>10.10± 0.11</td>
<td>9.08± 0.09</td>
<td><strong>9.65± 0.06</strong></td>
<td>9.08± 0.09</td>
<td>9.38± 0.03</td>
<td>9.31± 0.03</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>6.02± 0.07</td>
<td>5.57± 0.06</td>
<td><strong>5.77± 0.21</strong></td>
<td>5.53± 0.06</td>
<td>5.09± 0.12</td>
<td>5.30± 0.03</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>1.49± 0.04</td>
<td>0.91± 0.03</td>
<td>1.19± 0.04</td>
<td>1.05± 0.07</td>
<td>0.92± 0.05</td>
<td><strong>1.83± 0.04</strong></td>
</tr>
<tr>
<td><strong>Minerals &amp; Vitamins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>22.84± 0.22</td>
<td>14.09± 0.10</td>
<td><strong>19.81± 0.02</strong></td>
<td>13.00± 0.16</td>
<td>18.99± 0.13</td>
<td>18.95± 0.14</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>192.08± 0.15</td>
<td>182.29± 0.55</td>
<td><strong>184.32± 0.02</strong></td>
<td>178.40± 0.36</td>
<td>183.31± 0.04</td>
<td>175.00± 0.05</td>
</tr>
<tr>
<td>Phosphorus (mg)</td>
<td>72.81± 0.59</td>
<td>65.32± 0.03</td>
<td><strong>67.95± 0.05</strong></td>
<td>63.98± 0.07</td>
<td>66.99± 0.06</td>
<td>64.99± 0.05</td>
</tr>
<tr>
<td>Vit. C (mg)</td>
<td>34.62± 0.04</td>
<td>21.52± 0.06</td>
<td><strong>28.01± 0.04</strong></td>
<td>20.97± 0.07</td>
<td>27.33± 0.05</td>
<td>25.01± 0.08</td>
</tr>
</tbody>
</table>
As depicted in Table 2, when comparing the fresh and cooked leaves, the amount of all nutrients except moisture and fat were higher in fresh leaves. Among the cooked leaves, the steamed one poses majority of nutrients as carbohydrates, protein, iron, calcium, phosphorus and vitamin C (9.65g, 5.77g, 19.81mg, 184.32mg 67.95mg and 28.01mg respectively) in higher amount as compared with other cooked leaves.

Maximum ash and moisture content (1.39g and 89.87% respectively) were observed in pressure cooked leaves. Since oil is the medium of cooking in sautéing, the sautéed leaves possess highest amount of fat content as 1.83g which is even higher than fresh leaves (1.49g). for vegetables, the cooking loss of minerals was high [6] and cooking reduces the vitamin C content of leaves in a larger amount [7].

Beta carotene values were found to be in very negligible amounts in leaves and green berries of *Solanum nigrum* Linn.

3.3 Percentage of nutrient retention in *Solanum nigrum* Linn. leaves on cooking

Percentage of nutrient retention in *Solanum nigrum* Linn. leaves upon various cooking methods is shown in Figure 1 and 2.

### 3.3.1 Percentage of retention for proximate principles

![Figure 1 Percentage of retention for proximate principles in cooked Solanum nigrum Linn. leaves](image)

The percentage of nutrient retention in *Solanum nigrum* Linn. leaves subjected to different cooking methods was calculated. For the same, the nutrient content of fresh *Solanum nigrum* Linn. leaves was considered as the standard values. Considering the cooked leaves, the boiled, steam cooked and pressure cooked leaves possess higher moisture content (103.91, 102.01 and 106.58 % respectively) when compared with fresh leaves (100 %). This may be due to absorption of water during cooking.

The percentage of retention for fat was higher in sautéed leaves (122.81 %) as compared with fresh and other cooked leaves. This was due to the addition of fat as the medium of cooking in sautéing.

Among the cooked leaves, the percentage of nutrient retention for proximate principles such as carbohydrates (95.54%) and protein (95.84%) was observed in steamed leaves.

### 3.3.1 Percentage of retention for minerals and vitamin

A remarkable reduction in percentage of retention for iron and vitamin C was observed in all the cooked leaves as compared with fresh leaves. Usually home processing methods exhibited a visible reduction in iron and vitamin C content in different leaves [7].

Among the cooked leaves, the percentage of nutrient retention for all the selected minerals and vitamin [iron (86.73%), calcium (95.96%), phosphorus (93.32%) and vitamin C (80.9%)] was observed in steamed leaves.
Figure 2 Percentage of retention for minerals and vitamin in cooked Solanum nigrum Linn. Leaves

3.4 Nutrient content of Solanum nigrum Linn. green berries

Nutrient content in fresh and cooked Solanum nigrum Linn. green berries are depicted in Table 3.

Table 3 Nutrient content of Solanum nigrum Linn. green berries

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Fresh green berries</th>
<th>Boiled</th>
<th>Steamed</th>
<th>Pressure cooked</th>
<th>Microwave cooked</th>
<th>Sautéed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ash (g)</td>
<td>1.81±0.03</td>
<td>1.44±0.05</td>
<td><strong>1.56±0.03</strong></td>
<td>1.43±0.01</td>
<td>1.45±0.04</td>
<td>1.52±0.04</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>90.85±0.05</td>
<td>92.80±0.03</td>
<td>92.14±0.05</td>
<td><strong>93.30±0.03</strong></td>
<td>64.01±0.05</td>
<td>70.62±0.04</td>
</tr>
<tr>
<td>Crude Fibre (g)</td>
<td>5.52±0.06</td>
<td>4.72±0.04</td>
<td><strong>5.12±0.03</strong></td>
<td>4.79±0.04</td>
<td>5.00±0.03</td>
<td>5.03±0.05</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>16.88±0.04</td>
<td>15.40±0.06</td>
<td><strong>16.20±0.04</strong></td>
<td>15.00±0.04</td>
<td>15.77±0.04</td>
<td>16.00±0.01</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>7.95±0.06</td>
<td>6.87±0.06</td>
<td>7.40±0.04</td>
<td>6.96±0.06</td>
<td><strong>7.51±0.05</strong></td>
<td>7.30±0.04</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>5.50±0.26</td>
<td>5.20±0.10</td>
<td>5.26±0.25</td>
<td>5.13±0.05</td>
<td>5.33±0.05</td>
<td><strong>6.83±0.25</strong></td>
</tr>
</tbody>
</table>

When comparing the fresh and cooked green berries, majority of nutrients (all except moisture and fat) were found higher in fresh green berries which is depicted in Table 4. Similar results in case of Solanum nigrum Linn. leaves was observed for berries also. Since water is in direct contact with berries in boiling, steaming and pressure cooking, those methods exhibited higher moisture content (92.80%, 92.14% and 93.30% respectively). This may be due to the absorption of water upon cooking. Review studies showing that as comparing with conventional
cooking methods, microwave cooking causes greater moisture loss [8]. The same result was observed in this study as the moisture content of green berries in microwave cooking reduced to 64.01 per cent.

As in the case of leaves, sautéed berries also exhibited more fat content (6.83g) due to the addition of oil as the medium of cooking in sautéing.

Content of ash (1.56g), crude fibre (5.12g), carbohydrate (16.2g), iron (10.15mg), calcium (31.95mg), phosphorus (54mg) and vitamin C (12.28mg) were higher in steamed green berries as compared with the same subjected to other cooking methods. Review studies revealed that a significant reduction of ascorbic acid (50.4%) and phosphorus content (41.4%) in green leafy vegetables upon cooking [9]. Similar results were observed in case of green berries also.

3.5 Percentage of nutrient retention in Solanum nigrum Linn. green berries on cooking

Percentage of nutrient retention for Solanum nigrum Linn. green berries subjected to various methods of cooking is shown in Figure 3 and 4.

3.5.1 Percentage of retention for proximate principles

The percentage of nutrient retention for selected nutrients in cooked green berries was calculated by considering the fresh green berries as standard.

Percentage of retention for moisture content in boiled, steam cooked and pressure cooked green berries (102.14, 101.41 and 102.69 % respectively) were slightly higher as compared with fresh green berries (100 %) due to the absorption of water. Similar in case of leaves, percentage of nutrient retention for fat was high (124.18 %) in sautéed green berries as compared with other cooking method.

Comparing the percentage of retention among cooked green berries, proximate principles such as ash content (86.18 %), crude fibre (92.75 %) and carbohydrate (95.97 %) were retained in higher percentage for steaming method. As per review studies based on the Asian habits of cuisine, steaming will help to reserve ultimate benefits of health promoting factors [10].

3.3.1 Percentage of retention for minerals and vitamin

A remarkable reduction in the percentage of retention for minerals (iron, calcium, phosphorus) and Vitamin C in cooked green berries as compared with fresh green berries was observed (Fig.4). An average of 60-70 percent of mineral content will be retained as compared with that in raw food in mass cooking [6].
Comparing the percentage of nutrient retention among cooked green berries, selected minerals and vitamin such as Iron (84.65%), Calcium (91.25%), Phosphorus (92.22%) and Vitamin C (64.73%) were retained in higher percentage for steaming method. A better retention of nutrients in green leafy and other vegetables and upon steaming was also observed on USDA table for nutrient retention factors [4].

4. Conclusion

Considering the nutrient content and percentage of nutrient retention for Solanum nigrum Linn leaves and green berries for different cooking methods, steam cooked leaves and green berries exhibited more nutrients in higher amount. Hence, the percentage of nutrient retention for majority of the nutrients was also high in steamed Solanum nigrum Linn. leaves and green berries. Since, the consumption of fresh Solanum nigrum Linn. leaves and green berries are not advisable for human, steaming is the best method of cooking for Solanum nigrum Linn. leaves and green berries for a better health benefit of the same. Because, steaming used less water for cooking and its direct contact with food item is not present. This may reduce the leaching of nutrients from the food item during cooking.

References:

