Nutritional Evaluation of Squash (Sechium Edule) Germplasms Collected from Garo Hills of Meghalaya – North East India

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Abstract

The present investigation analysed the fruits of 10 accessions of Sechiumedule (Squash) for different physico-chemical parameters. The parameters analysed included physical characteristics such as fruit color, fruit size, pulp ratio and nutritional parameters such as total sugar, reducing sugar, non reducing sugar, protein content, ascorbic acid content and crude fibre. Results indicated that the germplasm collected are rich in important nutritional parameters. The fruits analysed have very high moisture content ranging from 89.3-94.2% but are not a good source of protein which ranged from 0.77-1.05% in the fruits. The juice extracted from the fruits was rich in Vitamin C content and the Germplasm GH10 had the highest Vitamin C content (22.3%). Fruits of Sechiumedule also have significant amount of carbohydrate (4.12-4.98%), crude fibre (4.88-5.89 %) and Mineral Ash (0.245-0.321%).

Highlight

- A Cucurbitaceae family vegetable crop Sechiumedule is very popular in the North Eastern states of India.
- The vegetable crop has immense diversity and this research article is an attempt to collect the diverse samples from Garo Hills District of Meghalaya and analyse them for physico-chemical characteristics.
- The findings indicate that the vegetable has average amount of all nutritional components including significant amount of Vitamin C.
- The high moisture content in the crop results in very short shelf life of the fruits and methods need to be explored to increase the shelf life of the raw vegetable as well as formulate new processed products from the fruits.

Keywords: Sechiumedule, chayote, nutritional evaluation

Sechiumedule is a hairy climbing shrub belonging to the Cucurbitaceae family which also includes melons, pumpkin, cucumber as members. The plant is a native of Mountains of Central America where it was first domesticated by Aztecs (Singh 2002). Sechium edule is traditionally used in Mexico as a therapeutic resource against renal diseases and to control high blood pressure (Galia Lombardo-Earl et al. 2014). It is also called as Chayote (Hindi Language), Chow – Chow, Isqush (Nepali), Piskut (Khasi language) and Sikut (Garo language). The extracts of the leaves of the plant have shown to have anti hypertensive properties owing to significant amount of trans cinnamic acid and phenyl acetic acid (Ragasa et al. 2014). Although the plant is a native of Mexico the North Eastern part of India has considerable diversity of Sechiumedule particularly in the states of Mizoram, Meghalaya and Sikkim (Rai et al. 2006, Yadav et al. 2005). The plant is also extensively grown in the North East India as an important home garden crop used for marketing as well as self use purpose (Sahoo et al. 2010). Considerable variations are found in Chayote in respect of Fruit size, shape, color, presence of spines and nutritional composition of the fruits. It is unique among the cultivated cucurbits by bearing a single seeded fruits and exhibiting vivipary (Aung et al. 1990). It has a delicate flesh which makes it...
highly perishable having a very short shelf life. Owing to these features the tribal farmers growing the crop have to sell the products at very cheap prices leading to economic losses.

The fruits of Chayote are used as vegetable and have a squash like flavour when cooked. It is regarded as an important item in the daily diet among the people of North Eastern State including Meghalaya. The product is gaining popularity among the local population as a vegetable and recently attempts have been made to export the organically produced fruits of Chayote to neighbouring countries by the State Government of Meghalaya.

Several studies have been done to determine the nutritional evaluation of vegetables and products derived from them of the *Cucurbitaceae* family (Sew *et al.* 2010). Studies to analyse the physico-chemical attributes of *Sechiumedule* germplasms are very few in number and there is dearth of research to enumerate the vast diversity of the crop. The present investigation has thus been undertaken to collect fruit samples of different germplasms of Chayote from three Garo Hills district (West, North, and South West Garo Hills) of Meghalaya and analyse them to determine the diversity of physico-chemical attributes of the samples.

**Materials and Methods**

**Sample Collection**

Mature healthy fruit samples were collected from local growers from five districts of Garo hills (East, West, North, South and South West Garo Hills) of Meghalaya during the months of October and November, 2013. The collected fruits were wrapped in a polyethylene bags and carried to the lab at room temperature so as to analyse the fruits. The fruits were coded serially as GH1, GH2, GH3, GH4, GH5, GH6, GH7, GH8, GH9 and GH10 to ensure their identity.

**Physical Characteristics**

The collected fruit samples were studied for fresh fruit weight (g), fruit colour, presence of spines on fruit skin, fruit length (cm), fruit diameter (cm). The fruits were washed with tap water and allowed to dry under room temperature. The fruits were peeled manually and cut with a knife to recover the seed. All the components viz: fruit, the peeled skin and seeds were weighed separately to determine the pulp recovery of the fruit samples. Observations were also made for juice%, Total Soluble Solids(%), Acidity(%). Total Soluble Salts (TSS) was determined by Zeiss hand refractometer.

**Nutritional Composition**

Uniformly sized fruit samples were collected and washed thoroughly with tap water. The fruit samples were sliced (unpeeled) into 4-5mm slices and allowed to dry under room temperature for three hours to remove excess moisture. For all the analysis except the moisture content the fruit samples in triplicate were dried in an air oven at 55°C for 36 hours and finely powdered with a pestle and mortar. The powder was kept in a sealed polyethylene pouch and kept in refrigerator for further analysis. Care was taken to analyze the components within 2-3 days from collecting the fruit samples so as to avoid errors due to storage conditions. The determination of Vitamin C was done in fresh fruits only.

**Estimation of Total Carbohydrate**

The total carbohydrate content of fruit samples of both the groups was determined as per the Anthrone method (Yem and Willis, 1954). Fruit sample (0.1 g) was extracted in 80% ethanol solution. Dried fruit sample was ground so as to pass through 1 mm sieve and it was shaken for 6 hrs at 60°C. This extract was used for the estimation of carbohydrates. Fruit extract (100 mL) was taken in 25 mL test tubes and 6 mL anthrone reagent was added, and then heated in boiling water bath for 10 min. The test tubes were ice cooled for 10 min and incubated for 20 min at room temperature (25°C). Optical density was read at 625 nm on a UV-Vis spectrophotometer. Blank was also read in the same way. The total carbohydrates were calculated from the standard curve developed by using following the above mentioned method.

**Estimation of Total Protein**

The total protein content of the fruit samples was determined by A.O.A.C. Kjeldahl method (AOAC, 1990) for plants. The automated Kjeldahl apparatus KEL-PLUS (Pelican instruments) was used to analyse the samples. The protein content in the fruit sample was calculated as per the following formula:

\[
\text{% Nitrogen} = \frac{\text{normality of acid} \times \text{titre value} \times 100}{\text{Sample weight} \times 1000}
\]

Protein percent = 6.25 × % nitrogen

**Moisture content**

The moisture content was determined as per the method prescribed by AOAC (1990). 5.0 g of samples were taken in pre-weighed crucible and placed in an air oven
maintained at 105°C for 8 hr. The crucibles were transferred immediately to desiccators, cooled and weighed. All the analysis was done in triplicates. The moisture content determined in the fruit sample was calculated as follows:

\[
\text{Moisture (\%)} = \frac{\text{loss in weight (g)}}{\text{Weight of sample (g)}} \times 100
\]

**Crude Fibre content**

The determination of crude fibre was done using methods of Association of Official Analytical Chemists (AOAC, 1990). Powdered fruit sample weighing 1.5 g was digested in 1.25% sulphuric acid, filtered and washed with hot water. The digestion was repeated in 1.25% sodium hydroxide and sample was filtered on a sintered glass filter which was then oven dried and placed in a muffle furnace at 600°C to ash the sample. The filter was cooked in a desiccator and weighed. Crude fibre content was expressed as percent weight loss resulting from ashing.

**Mineral Ash**

The mineral ash content in the fruit samples of *Sechium edule* was done according to the method of Association of Official Analytical Chemists (AOAC 1990). Three clean crucibles were placed in a muffle furnace at 600°C for an hour. The crucibles were transferred to a desiccator, cooled to room temperature and weighed. Samples of 1.5 g each were accurately weighed into the cooled crucibles which were transferred to a muffle furnace set at 600°C and left to ash for 6 hrs. The crucibles were transferred to a desiccator, cooled to room temperature and weighed. The mineral ash content of the pulp was calculated on a dry weight basis by expressing mass of the ash as a percentage of the dry mass of the original sample.

**Vitamin C content**

Vitamin C was determined by using the procedure as outlined by Nielsen (1998). The fresh fruit sample (10 g) was accurately weighed and ground using mortar and pestle with an addition of 20 ml of metaphosphoric acid acetic acid. The mixture was further ground and strained through muslin and the extract was made up to 100 ml with the metaphosphoric-acetic acid mixture. 5 ml of the metaphosphoric acid-acetic acid solution was pipetted into three of the 50 ml Erlenmeyer flask followed by 2 ml of the samples extract. The samples were titrated separately with the indophenol dye solution until a light rose pink persisted for 5 s. The amount of dye used in the titration were determined and used in the calculation of vitamin C content.

**Results and Discussion**

**Physical Parameters**

The observations made on the fruit samples revealed a considerable variation in all the physical parameters studied (Table 1). The fruit weight in the collected samples ranged from 0.149kg to 0.385 kg. The sample GH3 exhibited the highest fruit weight (0.385kg) and was followed by GH5 (0.339kg). The sample GH3 also exhibited the highest fruit length (12.8cm) while the least fruit length was observed in the sample GH8. The fruit diameter in the collected samples ranged from 3.9cm to 7.7cm with the sample GH2 exhibiting the highest fruit diameter (7.7cm) followed by sample GH3 (7.6cm). Observations recorded with respect to the size (including weight and length) showed that sample GH3 had the largest fruit size and was closely followed by the sample

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Fruit Weight (in kg)</th>
<th>Fruit Length (in cm)</th>
<th>Fruit Diameter (in cm)</th>
<th>Fruit Color</th>
<th>Pulp Recovery (in %)</th>
<th>Spines on Fruit Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH1</td>
<td>0.247</td>
<td>12.3</td>
<td>6.9</td>
<td>Light Green</td>
<td>89.06</td>
<td>P</td>
</tr>
<tr>
<td>GH2</td>
<td>0.327</td>
<td>11.3</td>
<td>7.7</td>
<td>Light Green</td>
<td>89.29</td>
<td>A</td>
</tr>
<tr>
<td>GH3</td>
<td>0.385</td>
<td>12.8</td>
<td>7.6</td>
<td>Yellowish Green</td>
<td>92.22</td>
<td>A</td>
</tr>
<tr>
<td>GH4</td>
<td>0.288</td>
<td>10.7</td>
<td>7.3</td>
<td>Light Green</td>
<td>90.27</td>
<td>A</td>
</tr>
<tr>
<td>GH5</td>
<td>0.339</td>
<td>12.4</td>
<td>7.4</td>
<td>Light Green</td>
<td>91.16</td>
<td>A</td>
</tr>
<tr>
<td>GH6</td>
<td>0.180</td>
<td>11.3</td>
<td>6.4</td>
<td>Dark Green</td>
<td>89.38</td>
<td>A</td>
</tr>
<tr>
<td>GH7</td>
<td>0.172</td>
<td>11.7</td>
<td>4.2</td>
<td>Dark Green</td>
<td>88.37</td>
<td>P</td>
</tr>
<tr>
<td>GH8</td>
<td>0.127</td>
<td>10.1</td>
<td>4.0</td>
<td>Dark Green</td>
<td>88.97</td>
<td>P</td>
</tr>
<tr>
<td>GH9</td>
<td>0.156</td>
<td>11.1</td>
<td>3.9</td>
<td>Dark Green</td>
<td>87.82</td>
<td>A</td>
</tr>
<tr>
<td>GH10</td>
<td>0.149</td>
<td>10.2</td>
<td>4.3</td>
<td>Dark Green</td>
<td>88.59</td>
<td>P</td>
</tr>
<tr>
<td>Mean</td>
<td>0.237</td>
<td>11.39</td>
<td>5.97</td>
<td></td>
<td>89.51</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>0.149-0.385</td>
<td>10.1-12.8</td>
<td>3.9-7.7</td>
<td></td>
<td>87.82-92.22</td>
<td></td>
</tr>
</tbody>
</table>
GH5. These features determine the overall yield potential of the germplasms and can play a vital role in popularizing the appropriate germplasm to other areas considering the agronomic potential of the germplasm. Unlike most of the other members of the Cucurbitaceae family the fruits of Chayote are single seeded. The data recorded for the pulp recovery indicated that the sample GH3 had the maximum pulp recovery (92.22%) while lowest pulp recovery was recorded in the sample GH9 (87.82%).

The pulp recovery depends on the size of the seed and also the thickness of the fruit skin. These factors may have led to variations in the pulp recovery among the samples collected. The variations in the samples collected were also evident in the color of fruits as they had light green, yellowish green and dark colors. The preference for vegetables depends significantly on the skin color and the vegetables having dark green color appear more fresh and attractive leading to more acceptance among the customers in the region.

The fruit skin of the Chayote fruits were either smooth in texture (samples GH2, GH3, GH4, GH5, GH6 and GH9) or had spines (GH1, GH7, GH8 and GH10). The difference in genetic makeup of the germplasms may lead to variations in the morphological features of agrihorti products. Findings of Rai et al. 2006, made with respect to the Chayote germplasms corroborate the results of the present investigation. Similar findings have been reported in case of cereal crops such as barley by (Raikwar and Mishra, 2012), in bottle gourd by (Sharma and Sengupta, 2013) and in tomato by (Prajapati et al. 2015).

Nutritional Parameters of *Sechium edule* Fruit Samples

*Sechium edule* fruits are widely used by the local population as a vegetable used to prepare a variety of dishes. It is also used for preparation of juice. The quantity and quality of the juice extracted from the Chayote samples exhibited considerable variation. Maximum juice percent was recorded in the sample GH4 (72.6%) which was followed by GH5 (68.6%). The Total soluble Solids (TSS) and the Acidity of the juice extracted from the samples ranged from 4.1 to 5.3% and 0.10 to 0.28% respectively. The Vitamin C content in the samples collected ranged from 14.6 to 22.3%. The sample GH-10 was the best accession in terms of the Vitamin C content in the fruits.

It was followed by the sample GH-9 having, 21.2% Vitamin C content. Ellong et al. (2015) reported that Vitamin C content in the *Sechium edule* fruits ranged from 7.4 to 12.5%. The fruit samples exhibited limited variations for carbohydrate content also. It ranged from 4.12% to 4.98% in the samples GH-6 and GH-5 respectively. The protein content in the fruits also had limited variation and it ranged from 0.28% to 1.05% in the samples GH-6 and GH-5 respectively. The protein content in the fruits were also fair source of fibre also. The fruits analysed showed that the crude fibre content ranged from 4.88 to 5.89% and the mineral ash content ranged from 0.245 – 0.321%. The findings are in accordance with the results of studies as reported by (Aung et al. 1990; Yadav et al. 2005; Rai et al. 2006; Sanwal et al. 2008 and 2010).

**Table 2. Nutritional Parameters of the *Sechium edule* fruit samples of Garo Hills of Meghalaya**

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Juice (%)</th>
<th>TSS of Juice (%)</th>
<th>Acidity of Juice (%)</th>
<th>Moisture (%)</th>
<th>Carbohydrate Content (%)</th>
<th>Protein Content (%)</th>
<th>Crude Fibre (%)</th>
<th>Vitamin C (%)</th>
<th>Mineral Ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH1</td>
<td>45.6</td>
<td>5.3</td>
<td>0.10</td>
<td>89.3</td>
<td>4.89</td>
<td>0.77</td>
<td>5.54</td>
<td>15.5</td>
<td>0.245</td>
</tr>
<tr>
<td>GH2</td>
<td>49.8</td>
<td>5.1</td>
<td>0.16</td>
<td>90.2</td>
<td>4.34</td>
<td>0.71</td>
<td>5.65</td>
<td>18.4</td>
<td>0.321</td>
</tr>
<tr>
<td>GH3</td>
<td>64.9</td>
<td>4.8</td>
<td>0.14</td>
<td>91.6</td>
<td>4.21</td>
<td>0.82</td>
<td>5.89</td>
<td>14.6</td>
<td>0.306</td>
</tr>
<tr>
<td>GH4</td>
<td>72.6</td>
<td>4.3</td>
<td>0.24</td>
<td>89.4</td>
<td>4.62</td>
<td>0.79</td>
<td>5.73</td>
<td>16.2</td>
<td>0.298</td>
</tr>
<tr>
<td>GH5</td>
<td>68.6</td>
<td>4.1</td>
<td>0.22</td>
<td>90.6</td>
<td>4.98</td>
<td>0.85</td>
<td>5.51</td>
<td>15.1</td>
<td>0.265</td>
</tr>
<tr>
<td>GH6</td>
<td>51.2</td>
<td>4.5</td>
<td>0.28</td>
<td>92.1</td>
<td>4.12</td>
<td>0.99</td>
<td>4.91</td>
<td>19.2</td>
<td>0.276</td>
</tr>
<tr>
<td>GH7</td>
<td>58.8</td>
<td>5.2</td>
<td>0.12</td>
<td>90.4</td>
<td>4.22</td>
<td>0.96</td>
<td>4.93</td>
<td>17.8</td>
<td>0.293</td>
</tr>
<tr>
<td>GH8</td>
<td>56.3</td>
<td>4.8</td>
<td>0.16</td>
<td>94.2</td>
<td>4.45</td>
<td>0.85</td>
<td>4.95</td>
<td>20.4</td>
<td>0.286</td>
</tr>
<tr>
<td>GH9</td>
<td>47.9</td>
<td>4.2</td>
<td>0.16</td>
<td>92.8</td>
<td>4.56</td>
<td>0.94</td>
<td>4.88</td>
<td>21.2</td>
<td>0.281</td>
</tr>
<tr>
<td>GH10</td>
<td>56.8</td>
<td>4.1</td>
<td>0.26</td>
<td>90.2</td>
<td>4.71</td>
<td>1.05</td>
<td>5.09</td>
<td>22.3</td>
<td>0.303</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>56.85</strong></td>
<td><strong>4.64</strong></td>
<td><strong>0.186</strong></td>
<td><strong>91.08</strong></td>
<td><strong>4.51</strong></td>
<td><strong>0.873</strong></td>
<td><strong>5.308</strong></td>
<td><strong>18.07</strong></td>
<td><strong>0.287</strong></td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td><strong>45.6-72.6</strong></td>
<td><strong>4.1-5.3</strong></td>
<td><strong>0.10-0.28</strong></td>
<td><strong>89.3-94.2</strong></td>
<td><strong>4.12-4.98</strong></td>
<td><strong>0.77-1.05</strong></td>
<td><strong>4.88-5.89</strong></td>
<td><strong>14.6-22.3</strong></td>
<td><strong>0.245-0.321</strong></td>
</tr>
</tbody>
</table>
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research efforts need to be undertaken to make processed products from the fruits.

Acknowledgements

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