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Nutritional analysis of *Solanum incanum* L. (Bitter Brinjal) cultivated in north east region of India

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Abstract
North Eastern region of India, one of the global hot-spot, is also bestowed with various wild species of egg plants, *Solanum incanum* is one among them. It is highly neglected plant of this region despite the fact that it is a promising candidate for having both nutritional as well as medicinal value. *Solanum incanum* belongs to family Solanaceae which have global distribution due to its wide adaptive capacity. It is also one of the largest family of flowering plants consisting of numerous wild plants whose nutritional value is yet to be elucidated. The main objective of this present study is to elucidate its nutritional and economic importance among the local community through proximate analysis. Further work on this plant may bring out its additional value.

Keywords: solanaceae, *Solanum Incanum*, north-east India, proximate analysis

Introduction

Among the various families of flowering plants, the family Solanaceae is economically very important. Eggplant has its own significance because of its nutritional value and global distribution. Due to its versatility and capability to adapt to different climatic conditions, it can be grown throughout the year. The global area under brinjal cultivation has been estimated at 1.85 million ha with total production of about 55 million MTs (FAO data, 2016, http://faostat.fao.org/). In India, domesticated eggplant is one of the most common and principal vegetable crop having pan-India growing conditions except for higher altitudes. A large number of egg-plant species are wild in nature whose nutritional value is yet to be determined. *Solanum incanum* L. is a wild species of eggplant, thought to be originated in Africa but also prevalent in South Asia including the North-East region (Kanjilal U. N. *et al*., 1939 & Jain S.K. *et al*. 1986) [16, 15] of India. Being a wild species of eggplant, once planted, it can be easily maintained without any intensive care with maturation period of about 3 months. In its wild state, the plant is mostly dispersed through animals or wind. Due to the presence of thorns in the plant it is also known as "Thorn apple". It is also commonly known as "Bitter brinjal" since its fruits are bitter in taste. Due to lack of scientific information, its nutritional significance is still waiting to see the light of the day! It is reported that some farmers in the North-East region of India even destroy them when they observe them in their cultivation field. *S. incanum* L. is also reported to have medicinal values as well and is used in ethnic medicines (Mwonjoria J. K. *et al*., 2014) [18]. *S. incanum* L. is effective for control of cattle ticks when used as water extracted concoction (World Agroforestry Centre, 2014) [21]. However, unripe fruits of *S. incanum* L. were found to exhibit toxic effects in goats (Thaiyah A. G. *et al*., 2010) [24]. The leaves of *S. incanum* L. are rich in potassium (Auta & Ali, 2011) [2] and calcium (Abdalla I.M.F., 2015) [1]. This species is also believed to be used for the treatment of toothache, sore throat and chest complaints (Chevallier, 1996) [7]. The fruits of *S. incanum* L. are extensively used for the treatment of cutaneous mycotic infections and other pathological conditions and these fruit extracts have high antifungal and DPPH scavenging activity (Ghosal M. *et al*., 2012) [11]. Further, it has also been shown that the crude fruits sap extract of *S. incanum* L. have phytochemicals associated with insecticidal and deterrent activity (Umar A. *et al*., 2015) [25]. Besides, its stems and leaves have good prospects for compost preparation (World Agro-forestry Center, 2014) [21]. Generally, it does not require any external input in the form of fertilizers and manures, due to which it is also an indicator of low soil fertility. The fruits and leaves of *S. incanum* L. also shows antibiotic action which have been attributed to their content of solanine and related glycoalkaloids (Beaman-Mbaya V. *et al*.,1976; Britto S. J. *et al*., 2001; Fukuhara K. *et al*., 1991 & Indhumathi T. *et al*., 2013) [3, 6, 10, 14].

In Assam, the fruit of these plants are consumed as vegetable but is not much popular due to its bitter taste, though it is popular among few tribes of North East region as observed in Tawang, Arunachal Pradesh.

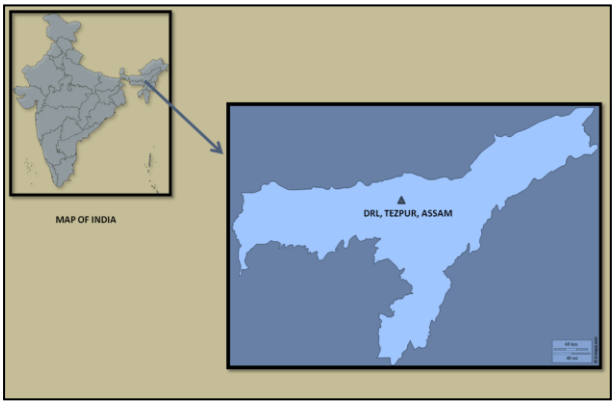

Fig 1: Map of Assam showing experimental location

Classification of *Solanum incanum* L.
Kingdom: Plantae
Class: Magnoliopsida
Subclass: Asteridae
Order: Solanales
Family: Solanaceae
Genus: *Solanum*
Species: *incanum*
Scientific Name: *Solanum incanum* L.
Common Name: Bitter Brinjal
Local Name (Manipuri): Khamen Akhabi
Local Name (Assamese): Titta Baingna
Local Name (Mizo): Samtrok

Fig 2: Plant of *Solanum incanum* L. (Close View)

Taxonomic identification of plant under study has been done using available botanical literature and other sources like previous publications (Lashin Gamal M.A., 2011; Sharma B.D., 1974; Bohsand L *et al*., 1997) [17, 23, 5].

Material and methods
Plant Description- The leaves of *Solanum incanum* L. plant are ovate or elliptic, entire or slightly lobed, base cuneate to rounded (Beentje, 1994) [4]. Besides, *S. incanum* L. exhibited a remarkable plasticity in its leaf traits (Gianoli *et al.*, 1999) [12]. Fruits are small in size, greenish in colour when immature and becomes deep yellow to red when ripe. In North-East India it is mainly present in the form of shrub whose height reaches upto 1.5 m bearing characteristics spines on the stems, stalks and calyces.
Solanum incanum L. used for this study were cultivated in the Agricultural Experimental Field of Defence Research Laboratory (DRL), DRDO, Tezpur, Assam (Figure 1 & 3) which is located at 26° 38' N, 92° 48'E. The size of the plot area was 15.8 ft. x 11.7 ft. mature fruits of these plants were harvested during pre-monsoon season. The proximate analyses of mature fruits were done at Defence Food Research Laboratory (DFRL), DRDO, Mysore, Karnataka.

Fig 3: Bitter Brinjal (*Solanum incanum* L.) cultivation in the DRL Agricultural Field

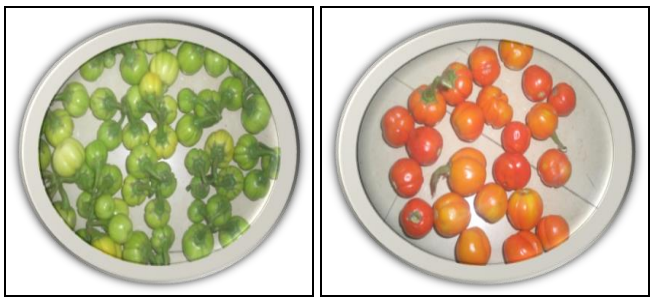

Fig 4: Green and mature fruit of *Solanum incanum* L. (Bitter Brinjal)

Proximate analysis
Estimation of moisture content (Hot Air Oven Method)
Moisture content was determined using AOAC (1984) [19] procedure. The sample was dried in a hot-air oven and the moisture content was calculated from the weight loss due to the evaporation of moisture. The moisture content was calculated using the following formula:

$$\text{Moisture content of Sample (\% mc)} = \frac{\text{Initial weight} - \text{Final Weight}}{\text{Weight of Sample}} \times 100$$

Estimation of ash content (Muffle Furnace Method)
Ash content of prepared sample was determined by AOAC method (2000). 10 g of sample was weighed in a dish. The dish was placed in a sand bath and was gently heated to a point of ignition and allowed to burn spontaneously. Thereafter, it was gently ignited; as a result, carbon residue was obtained. It was again placed in a muffle furnace at a temperature of 550°C - 600°C. This was done till carbon residue disappeared. It was allowed to cool and finally weighed. Ash content was determined by using the following formula:

$$\text{Ash content (gm)} = \frac{(\text{Weight of crucible and Ash}) - \text{Weight of empty crucible}}{\text{Weight of Sample}} \times 100$$

Estimation of fat content
Fat content was estimated by using Soxhlet extractor (Gerhardt, Germany) with continuous refluxing for 14 - 16 hrs described by AOAC (1984) [19]. Fat content was determined by using the following formula:

$$\text{Fat \%} = \frac{\text{Weight of ether extract}}{\text{Weight of Sample}} \times 100$$

Estimation of Crude Fiber (Fibretherm, Gerhardt, Germany)
Crude fibre is lost on ignition of dried residue which is left after sequential digestion of sample with 1.25 % H_2SO_4 & 1.25% NaOH solution specific conditions.

Preparation of Gooch Crucible
Cleaned and dried Gooch crucible was filled to 3/4th of its

column with dried asbestos powder and was fixed on to the filtration device. It was washed with distilled water. While adding distilled water suction was applied to facilitate the asbestos to settle tightly at the bottom of the crucible. The packed volume was not more than 1/8th of the total volume of the crucible. The packed Gooch crucible was washed under suction, by distilled water until the washings were clear. It was then dried in a hot air oven at 120°C for one hour and stored in a desiccator for further use.

Preparation of sample

The given sample was homogenized in a warring blender. The residue obtained after estimation of fat was finely grounded, preferably to pass through 100 mesh sieve and used for determination of crude fibre.

Procedure

2g of the prepared sample was weighed and placed in a wide mouth conical flask. Approximately 2 g of dried asbestos powder and bumping chips were added. 200 ml of 1.25 % H_2SO_4 was added and the condenser was fitted**.** The hot mixture was refluxed through a wetted muslin cloth spread over a Buchner funnel fitted to the suction unit. The residue was washed several times with hot distilled water until the filtrate is neutral. The residue was transferred quantitatively over the muslin cloth back into the same conical flask, with the help of 200 ml of 1.25 % NaOH. The mixture was again refluxed for 30 min. The digested material was filtered, under suction, through the prepared Gooch crucible. It was washed 3-4 times with hot distilled water. It was again washed with 10-15 ml 95 % alcohol followed by 10 -15 ml of solvent ether. The Gooch containing the residue was dried overnight in a hot air oven at 95±5°C. Thereafter, it was cooled in a dessicator and weighed (W1). The Gooch was transferred into a Muffle furnace and was ignited at 550 ± 5°C for 3-4 hrs. Then, it was cooled in a desiccator and weighed (W2). Crude fibre was determined by using the following formula:

$$\text{Crude fibre \%} = \frac{100 - (\text{Moisture} + \text{fat})}{\text{Weight of Sample taken}} \times \text{Weight of fibre}$$

Estimation of Protein by micro Kjeldahl method (PELICAN-Kelplus-KES06INL & Kelplus Classic DXVA, India):

The nitrogenous compounds are converted into ammonium sulphate by boiling with concentrated sulphuric acid. The ammonium sulphate formed is decomposed with a strong alkali (NaOH) and the ammonia liberated is absorbed in excess of neutral boric acid solution and then titrated with standard H.

$$\text{Sample} + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$
$$(NH_4)_2SO_4 + NaOH \longrightarrow NH_3 + Na_2SO_4 + H_2O$$

Procedure

- **Digestion**

0.5 G of sample was weighed into a digestion flask.1 gm of digestion mixture was added. Concentrated H_2SO_4 was added. The sample was digested in a mantle inside a fume hood. Heating was continued until the colour of the digested sample is pale green or colourless. It was left to cool and 30- 40 ml of distilled water was added slowly through the sides of the flask. It was mixed properly and left for cooling. The solution was transferred to a 100 ml volumetric flask. The flask was rinsed with distilled water and transferred in to the same volumetric flask and the volume was made up.

- **Distillation and Titration**

5 ml of the sample was transferred into the distillation unit. It was rinsed with 5 ml of distilled water. Thereafter, 10 ml of sodium hydroxide solution was added. 10 ml of boric acid was transferred into a 100 ml conical flask and 3-4 drops of mixed indicator was added. The flask was kept under the condenser. Now steam was passed into the distillation unit where sample and alkali were present. The liberated ammonia gets condensed into the boric acid. Distillation was continued for 5 minutes. Then distillation was stopped and the distillate was titrated against standard 0.01 N HCL.

- **Calculation**

This calculation is based on the fact that 1000 ml of 1N HCL = 14 g of Nitrogen.

$$\text{\% Nitrogen value of the sample} = \frac{\text{Titration value x N x 14 x 100 x 100}}{\text{Wt. of the sample x volume Taken x 1000 for distillation}}$$

$$= \%\ N_2 \text{ in g}$$

Nitrogen obtained is multiplied by the factor 6.25
I.e. N x 6.25 given protein % in gm.
Factor 6.25 is based on the assumption that plant protein contains 16 % nitrogen.

Estimation of reducing, total and non-reducing sugars by Fehling's method

Estimation of reducing sugars

5 ml of Fehling's solution A & B were taken in a conical flask and contents were boiled using Bunsen burner. Methylene blue indicator was added when it started boiling. The contents were titrated against the filtrate in the burette and the end point was observed till blue to brick red colour was obtained and it was confirmed by adding a drop of indicator into the flask. The titration was repeated in triplicates.

Estimation of total sugars

20 ml of the filtrate were taken in a 100 ml volumetric flask and 10 ml of concentrated hydrochloric acid were added and kept for overnight for acid hydrolysis. After that a drop of phenolphthalein indicator was added and a drop of saturated alkali was added to neutralize the acid where a pale pink color was obtained and the volume was made up to the mark using distilled water. 5 ml of Fehling's A & B were pipetted out into a conical flask. Contents were boiled and indicator was added and titrated against the filtrate and finally end point brick red colour standardization of Fehling's solution was done. Calculation of reducing sugar, total sugar and non-reducing

sugar were determined using the following formula:

- % of reducing sugar = $\frac{\text{Factor X 100 X 100}}{\text{Titer value X weight of sample}}$
- % of total sugar = $\frac{\text{Factor X 100 X 100 X 100}}{\text{Titer value X 20 X weight of sample}}$
- % of non-reducing sugar = total sugar – reducing sugar

Standardization of Fehling's solution

Calculation

100 ml of glucose solution = 100 mg of glucose
100 ml of glucose solution = 1000/100 = 10 mg of glucose
10 ml of Fehling's solution = x ml of glucose X 10 mg = titre value X 10 mg (factor)

Result and discussion

North Eastern region of India, being rich in plant diversity, has large number of non-traditional or underutilized food plants from Solanaceae family. As a matter of fact, a number of wild species from this family is prevalent in this region whose nutritional and medicinal value is yet to be determined. Moreover, several species are endemic in nature. In this context, it is imperative to analyse the wild phyto-bioresources prevalent in this hot-spot region of North-East India. Therefore in the present study, *S. incanum* L. were harvested and collected during pre-monsoon season from the study area. After collection, we observed that the structure of fruit is oval in shape and its colour is green when immature and becomes deep yellow to red when mature (Fig. 4). Proximate chemical analysis *viz.*, moisture (%), protein, fat, total ash, acid insoluble ash, carbohydrates, crude fibre, calorific value of fruits and seeds of Bitter Brinjal were evaluated and results are shown in Table 2 and Table 3 respectively. The number of fruits was found to be 3-5/bunch. *S. incanum* L. It was reported that the fruits of *S. incanum* L. may have a short shelf-life due to its high moisture content (Sambo *et al*., 2016) [22]. In the present study, we have also found remarkably high moisture content. In conformity with the earlier reports of high carbohydrate content (Auta & Ali,2011) [2], it can be observed from this study that *S. incanum* L. may be a good source of carbohydrates and is a good source of energy that can be utilized as human nutrition (Sambo *et al*., 2016) [22]. This plant can be utilized as a weapon against scurvy and other ascorbic acid deficiency related ailments due to presence of vitamin c in considerable amount in the fruits of *S. incanum* L (Edem & Miranda, 2011) [8].

Conclusion

The above study on the nutritional analysis of *S. incanum* L. (Bitter Brinjal) indicates that its fruit can be a potential source of nutritional stuff consisting of considerable amount of macronutrients *viz.* carbohydrate, crude fiber and fat. Besides, it is an important source of vitamin C, thiamine and folic acid with high moisture content in its fruit. Therefore, preservation of fruit through sun drying requires long time and strong light. Also, We observed that the average yield per harvest per plant is significantly high i.e. 1.3 kg, due to which one can obtain high yield from a small kitchen-garden plot of 10 ft x 10 ft for domestic consumption. In the present study, we have also found high amount of protein in the seeds of Bitter Brinjal. Besides, all the vital nutrients required for our body are available in reasonable quantity. Thus, this plant may become a promising candidate for balanced human nutrition, left apart its bitterness.

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Table 1: Physical characteristics of *Solanum incanum* L. (Bitter Brinjal)

S. No.		
1.	Date of sowing	22.10.14
2.	Date of germination	29.10.14
3.	Date of transplantation	16.11.14
4.	Date of flowering	05.01.15
5.	Date of fruit initiation	15.01.15
6.	Date of first harvest	20.02.15
7.	Average fruit yield / plant / harvest	1.3 kg
8.	Average no. of fruits / bunch	4
9.	Spacing	12 ft x 12 ft
10.	Parts used	Fruits

Table 2: Proximate Chemical Analysis of *Solanum incanum* L. (Bitter Brinjal) (FRUIT)

S. No.	Parameter	Value (Fruit)
1.	Moisture	89.56 %
2.	Protein	4.22 g/100 g
3.	Fat	0.6 g/100 g
4.	Total ash	1.08 g/100 g
5.	Acid insoluble ash	0.22 g/100 g
6.	Carbohydrates	2.6 g/100 g
7.	Crude Fibre	1.72 g/100 g
8.	Calorific Value	32.68 kcal/100 g

Table 3: Proximate Chemical Analysis of *Solanum incanum* L. (Bitter Brinjal) (SEED)

S. No.	Parameter	Value(Seed)
1.	Moisture	6.69 %
2.	Protein	21.03 g/100 g
3.	Fat	0.91 g/100 g
4.	Total ash	3.48 g/100 g
5.	Acid insoluble ash	1.22 g/100 g
6.	Carbohydrates	62.94 g/100 g
7.	Crude Fibre	3.73 g/100 g
8.	Calorific Value	344.07 kcal/100 g
9.	Vitamin C	3.36 mg/100 g
10.	Thiamine	33.51 mg/100 g
11.	Folic Acid	5.52 mg/100 g

References

1. Abdalla IMF. Leaves value of *Solanum incanum* (L) at Khartoum North-Sudan. International Journal of Engineering Science and Innovative Technology. 2015; 4(1):25-28.
2. Auta R, Ali I. Nutritional and chemical value of *Solanum incanum* (L) (bitter garden egg). International Journal of Tropical Medicine & Public Health. 2011; 1(1):96-107.
3. Beaman-Mbaya V, Muhammed SI. Antibiotic action of *Solanum incanum* (L). Antimicrobial Agents and Chemotherapy. 1976; 9(6):920-924.
4. Beentje H. Kenya trees, Shrubs and Lianas. National Museums of Kenya, Nairobi, 1994.
5. Bohsand L, Olmstead RG. Phylogenetic relationships in *Solanum* (Solanaceae) based on ndhF sequences. *Systematic Botany*. 1997; 22:5-17.
6. Britto SJ, Senthinkumar S. Antimicrobial activities of *Solanum incanum* (L) leaf extract. Asian Journal of Microbiology, Biotechnology & Environmental Science. 2001; 3(1-2):65-66.
7. Chevallier A. The Encyclopedia of Medicinal Plants, Dorling Kindersley Publishing, London, 1996.
8. Edem CA, Miranda ID. Chemical evaluation of proximate composition, ascorbic acid and anti-nutrients content of African star apple (*Chrysophyllum Afrcanum*) fruit. IJRRAS. 2011; 9(1):146-149.
9. FAO data. (http://faostat.fao.org/), 2005.
10. Fukuhara K, Kubo I. Isolation of steroidal glycoalkaloids from *Solanum incanum* (L) by two countercurrent chromatographic methods. Phytochemistry. 1991; 30(2):685-687.
11. Ghosal M, Mandal P. Phytochemical screening and antioxidant activities of two selected 'Bihi' fruits used as vegetables in Darjeeling Himalaya. International Journal of Pharmacy and Pharmaceutical Sciences. 2012; 4(2):567-574.
12. Gianoli Ernesto, Hannunen Salla. Plasticity of leaf traits and insect, 1999.
13. herbivory in *Solanum incanum* L. (Solanaceae) in Nguruman, SW Kenya. African Journal of Ecology. 1999; 38:183-187.
14. Indhumathi T, Mohandass S. Identification of bioactive compounds in *Solanum incanum* (L) fruit by Thin layer Chromatography and HPTLC. International Journal of Scientific Research. 2013; 296):22-25.
15. Jain SK, Borthakur SK. Solanaceae in Indian tradition, folklore, and medicine. In: Solanaceae: Biology and Systematics, edited by D'Arcy WG (New York: Colombia University Press), 1986, 577-583.
16. Kanjilal UN. *et al*. Flora of Assam (Shillong: Shillong Government Press). 1939; 3:593.
17. Lashin GMA. Palynology of six species of *Solanum* (Solanaceae). Life Science Journal. 2011; 8(4):687-697.
18. Mwonjoria John K. *et al*. Ethno, medicinal, phytochemical and pharmacological aspects of *Solanum incanum* (L). International Journal of Pharmacology and Toxicology. 2014; 2(2):17-20.
19. Official Methods of Analysis of AOAC International, 14th Edition, 1984.
20. Patel R. *et al*. Nutritional evaluation of *Canavalia ensiformis* (Jack bean) cultivated in North East region of India. International Journal of Botany Studies. 2016; 1(6):18-21.
21. Pesticidal Plant Leaflet. *Solanum incanum* L., World Agroforestry Centre, 2014.
22. Sambo HS. *et al*. Phytochemical, proximate and mineral analyses of *Solanum incanum* fruit, International Journal of Chemical,Material and Environmental Research. 2016; 3(1):8-13.
23. Sharma BD. Contribution of the palyotaxonomy of the genus *solanum* L. Journal of Palynology. 1974; 10(1):51-68.
24. Thaiyah AG. *et al*. Experimental *Solanum incanum* L. poisoning in goats. Bulletin of animal health and production in Africa, 2010, 58(1).
25. Umar A. *et al*. Bio Efficacy of Aqueous Crude Fruit Sap Extract of *Solanum incanum* (L) against Green Peach Aphids *Myzus persicae* Sulzer (Homoptera: Aphididae). Entomology, Ornithology & Herpetology, 2015; 5(1).