

# Anatomical and Biochemical Studies of *Solanum melongena* and *Solanum nigrum*

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**Abstract** Anatomical, mineral and nutritional studies were carried out on various parts of *Solanum nigrum* and *Solanum melongena* using standard techniques. Analysis of variance was employed for data analysis. Anatomical studies showed that the two species have similar features in the transverse sections of their leaves and stem but have dissimilar features in the transverse sections of their roots. The mineral result revealed varying quantities of the minerals in the various parts of the two species. The highest mineral composition in *S. melongena* was selenium ( $1030.0 \pm 10.0$ ) which was found in the root, while potassium ( $2.75 \pm 1.59$ ) which was found in the stem was the least. The highest mineral composition in *S. nigrum* was calcium ( $873.33 \pm 16.67$ ) which was found in the leaves, while potassium was the least ( $2.26 \pm 0.55$ ) found in the root. Vitamin studied showed varying quantities of the vitamins in the various parts of the two species. The highest vitamin was vitamin A in the root of both species when compared to the other parts. The implication is that the two species are closely related and this justified their placement in the same genus *Solanum* while the slight difference between them supports their separation into different species. The result also indicated that the various part of the two species contained adequate amount of vitamins and minerals for human consumption.

**Keywords** Anatomical, Mineral, Vitamins, *Solanum melongena*, *Solanum nigrum*

seeds. According to Hunziker (1979) *Solanum* species are herbs, leaves are simple, pinnate and alternate. Flowers are radically or rarely bilaterally symmetrical, with hypogenous discs; sepals are usually coalescent for almost their full length, the calyx is persistent often enlarging in fruits, corolla ovate to tabular, carpel 2, the style 1, and the ovary usually 2 chambered or sometimes 3-5 through irregularities of the placenta, parental-axile, ovules numerous in each carpel, fruit berry.

Economically, members of *Solanum* used are for the production of drugs e.g. pharmaceutical steroids. The leaf juice is used in treating inflammation of the kidney and bladder and in gonorrhoea, dropsy, heart diseases, bile and enlargement of the spleen (Pandey *et al.*, 2000). *Solanum* species have indigenous medicinal uses which range from weight reduction to treatment of several ailments including asthma, skin infections and constipation. Various plant parts are used in decoction for curing ailments such as diabetes, leprosy, haemorrhoids (Bello *et al.*, 2013). More so, the plants are known for their rich nutritional and mineral value. Physiognomic characters, phytochemicals and anatomical properties of plant parts are sources for taxonomic inferences in different groups of flowering plants (Harborne, 1973; Buchanan *et al.*, 2000). Therefore, the objectives of this study is to provide empirical data on the morphology, anatomy and nutrition of these varieties of *Solanum* species for accurate description and proper identification. This would go a long way in creating awareness and improve the consumption rate of these plants Ahmad *et al.*, (2010).

## 1. Introduction

The Solanaceae family comprises about 98 genera and 2,700 species with a wide distribution, mainly in the tropical and subtropical regions of the world (Olmstead and Bohs, 2007). *Solanum melongena* L. and *Solanum nigrum* L. belong to the family Solanaceae (Order-Solanales). They are dicotyledonous plants bearing barriers with numerous

## 2. Materials and Methods

**Sources of materials:** Samples of *S. melongena* and *S. nigrum* were collected from Agricultural Development Programme (ADP) farm in Awka North Local Government Area Anambra State and authenticated by a curator in the agency.

**Anatomical analysis:** Anatomy follows the method of (kadir and Adeniran, 2016) with some modification. The stem and midrib samples were freely sectioned using razor blade and the thin slices obtained were kept in water before transferring onto a glass slide where a few drops of 99% ethyl alcohol were added for tissue hardening and then 2 drop of safranin solutions. Excess stain was washed off with water before a drop of glycerin was added. Slides were covered with cover slips and ringed with nail lacquer. However, all preparations were observed with an Olympus microscope and photographs were taken with a digitized camera (Nikkon).

**Mineral analysis:** The species *S. melongena* and *S. nigrum* used for the study were harvested fresh. The leaves, stem and root were separated and washed with clean cold tap water and sun derived for 2 weeks. After drying, the leaves were grounded into a fine powder using a mortar and pestle, sieved and stored in air-light containers. The minerals in the leaf, stem and root analyzed from solution were obtained when 5g of the samples were digested with 10ml of SN concentrated hydrochloride. The mixtures were placed on a water bather and evaporated almost to dryness. The solution were cooled and filtrated into standard flask and diluted to volume with distilled water. Each experiment was repeated three times.

**Determination of calcium (Ca) and Magnesium (Mg):** The versanate EDTA titrimetric method of Udoh and Oguwale (1986) was employed. 20mls portion of each extract was dispersed into conical flask and treated with inches of masking agents (hydroxylamine hydrochloride, sodium cyanide and sodium potassium ferrocyanide). The flask was shaken and the mixture dissolved. 20mls of ammonia was added to it to raise the  $p^H$  to 10.00 (a point at which both calcium and magnesium form complexes with EDTA). The mixture was titrated against 0.02N EDTA solution using Erochiome Black T as indicator. A reagent black was titrated and titration in each case was done from deep red to a permanent blue endpoint. The titration value represents both calcium and magnesium ions in test sample. A repeat titration was done  $Ca^{2+}$  alone in the test samples, 10% NaOH was used in place of the ammonium buffer and solechrome dark blue indicator in place of Erichrome Black T

**Determination of Potassium (K):** The potassium content was determined by flame photometry. About 5mls of the sample was pipetted into a test tube in duplicate. Then 2mls of cobalt nitrite was added, shaken vigorously and allowed to stand for 45mins and centrifuged for 15mins. The supernatant was drained-off and 2mls of ethanol was added to the residue. The solution was shaken vigorously and centrifuged off and 2ml of distilled water was boiled for 10minutes with frequent shaking to dissolve

the precipitate. About 1ml of 1% chorine hydrochloride and 1ml of 2% sodium ferric cyanide was added. Then 2mls of distilled water was also added and then the solution was shaken to mix well. The absorbance was taken at 620nm against the blank.

**Determination of Heavy Metals (zinc, lead, iron, selenium and manganese):** 3g of each sample was weighed with electronic weighing balance into a 250ml beaker. 10ml of HCl was measured using measuring cylinder into the beaker containing the samples and kept for 2-3 minutes. Then 30ml of Nitric acid was measured also and added into the beaker of the sample. The beaker was heated on a hot plate for about 10-15 minutes at a temperature of between 65°C and 70°C to digest in the fume cupboard and the beaker removed from the hot plate and kept to cool (Ademoroti, 1996). After cooling, the digested sample was filtered into another beaker using funnel with filter paper, distilled water added into the filtrate to make up to 100ml and ready for analysis. The digested solutions were analyzed for the presence of zinc, lead, iron, selenium and manganese using atomic absorption spectrophotometer (Unicam 939 AAS) with different lamps in position.

## Vitamin Analysis

### Preparation of Sample:

The species *S. melongena* and *S. nigrum* used for the study was harvested fresh, the leaves, stem and root was separated and washed with clean cold tap water and sun derived for 2 weeks. After drying, the eaves were grounded into a fine powder using a mortar and pestle, sieved and stored in air-light containers.

The vitamins in the leave, stem and root of *S. melongena* and *S. nigrum* were determined by the official methods of the Association of official Analytical chemist (AOAC, 1990).

**Determination of Vitamin A (Retinol):** A quantity, one gram of the sample was weighed and macerated with 20ml of n-hexane in a test tube 10mins. The 3ms of the upper hexane extract was transferred into a dry test tube in duplicates and evaporated to dryness. Following this, 0.2ml of acetic anhydride chloroform reagent was added and 2ml of 50% trichloroacetic acid (TCA) in chloroform was also added. The absorbance was taken at 15seconds and 30seconds interval at 620mn.

**Determination of Vitamin C:** About 0.5g of the sample was weighted macerated with 10mls of 0.4% oxalic acid in a test tube for 10mins, centrifuged for 5mins and the solution filtered. 1ml of the filtrate was duplicated, 9mls of 2, 6- dichlorephenol-indophenols was added and absorbance was taken at 15sec and 30sec interval at 520nm.

**Determination of Vitamin E (Tocopherol):** 1g of the original sample was weighed, macerated with 20ml of n-hexane in a test tube for 10 minutes and centrifuged for 10mins. The solution was filtered; 5mls of the filtrate was transferred into a dry test tube in duplicates and evaporated to dryness in a boiling water bath. Following this, 2mls of 0.5n alcoholic potassium hydroxide was added and boiled for 30minutes in a water bath. Then 3mls of n-hexane was added and was shaken vigorously. The n-hexane was transferred into another set of test tubes and evaporated to dryness. A volume, 2mls, of ethanol was added to the residue.

Another volume, 1ml of 0.2% ferric chloride in ethanol was added. The 1ml of 0.5%  $\alpha^{\text{ii}}$   $\alpha^{\text{i}}$ -dipyridyl in ethanol was added followed by the addition of 1ml of ethanol to make it up 5mls. The solution was mixed and absorbance taken at 500nm against the blank.

### 3. Results

#### 3.1. Mineral Analysis Result

**Table 1.** Mineral composition of *S. nigrum* and *S. melongena*

Mineral (100ml)	Leave of <i>S. nigrum</i>	Leave of <i>S. melongena</i>	Stem of <i>S. nigrum</i>	Stem of <i>S. melongena</i>	Root of <i>S. nigrum</i>	Root of <i>S. melongena</i>
Calcium	873.33 ± 16.67	738.16 ± 11.17	553.66 ± 18.70	775.40 ± 8.16	387.33 ± 35.00	721.23 ± 10.12
Potassium	4.10 ± 1.53	2.75 ± 1.59	3.50 ± 1.10	1.15 ± 1.66	2.26 ± 0.55	4.90 ± 1.71
Magnesium	44.45 ± 0.89	39.35 ± 0.65	40.40 ± 0.75	33.09 ± 1.80	29.46 ± 0.40	32.38 ± 2.10
Selenium	730.0 ± 30.0	745.01 ± 13.5	680.0 ± 14.05	810.11 ± 14.16	655.0 ± 55.00	1030.0 ± 10.01
Zinc	248.33 ± 8.33	491.66 ± 85.00	150.10 ± 16.40	259.41 ± 15.40	123.33 ± 3.33	146.66 ± 3.33
Iron	64.81 ± 0.96	65.84 ± 0.78	51.01 ± 2.05	62.41 ± 2.11	36.86 ± 2.17	59.03 ± 4.10
Lead	49.35 ± 60.73	65.47 ± 43.58	57.61 ± 14.76	57.79 ± 18.10	68.68 ± 85.42	62.52 ± 8.42
Manganese	72.56 ± 2.31	75.63 ± 5.89	88.72 ± 1.40	90.01 ± 5.14	102.04 ± 0.51	120.5 ± 9.74

#### 3.2. Results are in Mean ± Standard Deviation

The result showed varying quantities of the mineral in the various parts of *S. melongena* and *S. nigrum* (Table 1). The highest mineral composition in *S. nigrum* was calcium (873.33 ± 16.67) found in the leaves while potassium was the least composition (2.26 ± 0.55) found in the roots. The highest mineral composition in *S. melongena* was selenium (1030.0 ± 10.01) found in the root while potassium (2.75 ± 1.59) found in the leaf was the lowest mineral composition.

**Table 2.** Vitamin composition of *S. nigrum* and *S. melongena*

Nutrient (100ml)	Leave of <i>S. nigrum</i>	Leave of <i>S. melongena</i>	Stem of <i>S. nigrum</i>	Stem of <i>S. melongena</i>	Root of <i>S. nigrum</i>	Root of <i>S. melongena</i>
Vitamin C	3.18 ± 0.76	0.92 ± 0.03	1.08 ± 0.10	1.12 ± 0.12	1.21 ± 0.05	1.62 ± 0.63
Vitamin A	54.99 ± 2.23	64.82 ± 2.02	66.52 ± 2.80	70.28 ± 3.30	94.66 ± 3.22	92.45 ± 4.21
Vitamin E	4.70 ± 0.36	5.10 ± 0.74	5.15 ± 0.74	5.55 ± 0.80	7.34 ± 1.49	6.10 ± 1.24

#### 3.3. Results Are in Mean ± Standard Deviation

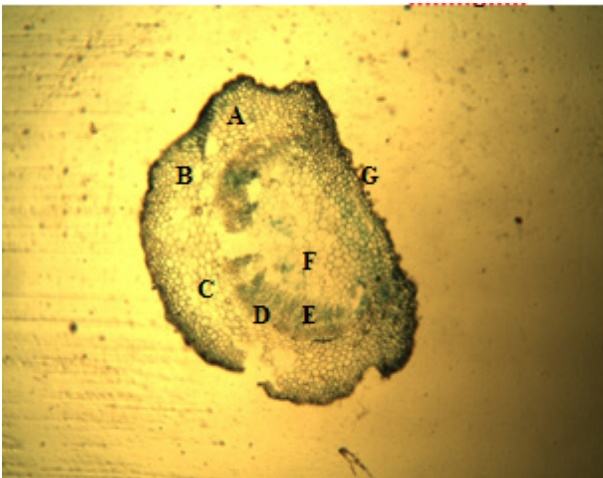
The result showed varying quantities of the vitamin in the various parts of *S. nigrum* and *S. melongena* (Table 2). The highest vitamin composition for *S. nigrum* vitamin A (94.66 ± 3.22) found in the roots while the least was Vitamin C (1.08 ± 0.10) found in the stem. Also, the highest vitamin composition for *S. melongena* was vitamin A (92.45 ± 4.21) found in the roots while the least was (0.92 ± 0.03) found in the leaves.

3.4. Transverse Section of the Leaf, Stem and Root of *S. nigrum* and *S. melongena*



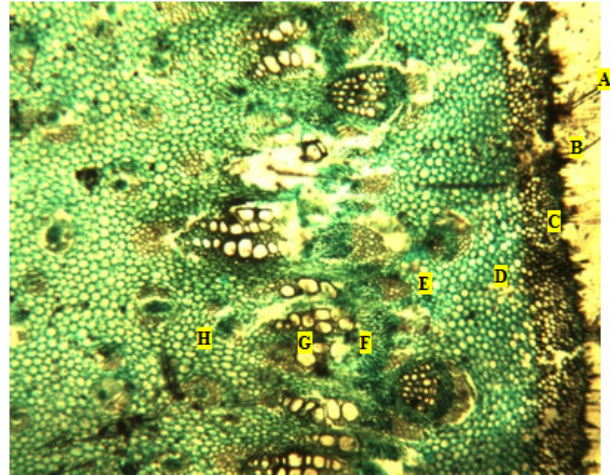
- A. Epidermis
- B. Collenchyma cells
- C. Cortex
- D. Phloem
- E. Xylem
- F. Pith

Plate 1. T/S of leaf of *Solanum melongena* ×100



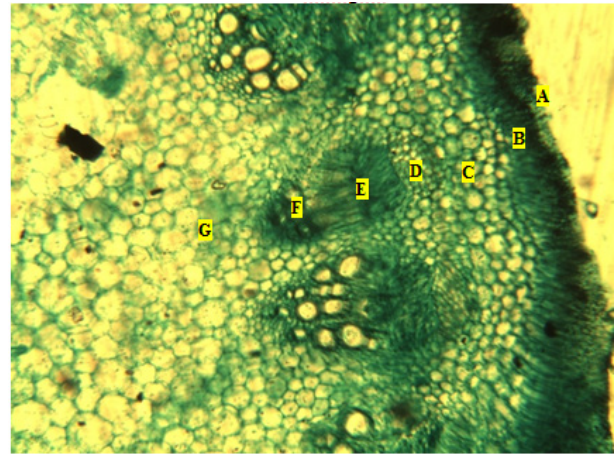
- A. Epidermis
- B. Parenchyma cells
- C. Cortex
- D. Phloem
- E. Xylem
- F. Pith
- G. Trichome

Plate 2. T/S of leaf of *Solanum nigrum* ×40



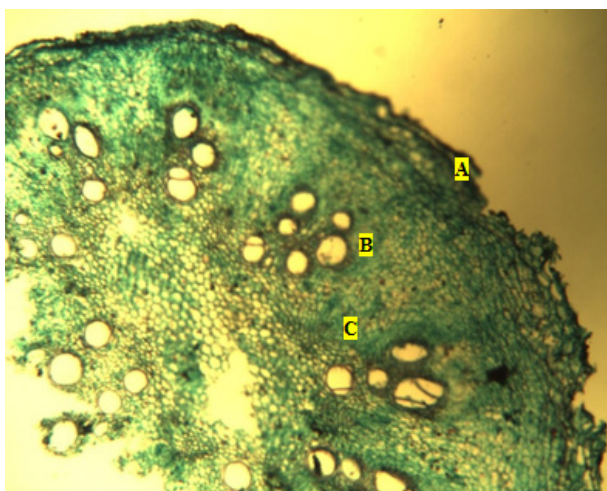
- A. Trichome
- B. Epidermis
- C. Collenchyma cells
- D. Cortex
- E. Phloem
- F. Sieve tube
- G. Xylem
- H. Pith

Plate 3. T/S of stem of *Solanum melongena* ×100



- A. Epidermis
- B. Collenchyma cells
- C. Cortex
- D. Parenchyma cells
- E. Phloem
- F. Xylem
- G. Pith

Plate 4. T/S of stem of *Solanum nigrum* ×100



- A. Cork
- B. Cortex
- C. Stele

**Plate 5.** T/S of root of *Solanum melongena* ×100



- A. Cork
- B. Cortex
- C. Stele

**Plate 6.** T/S of root of *Solanum nigrum* ×40

## 4. Discussion and Conclusions

In the anatomy of *S. melongena*, the mid-rib showed stellate trichomes in the epidermis made of a layer of cells. The collenchymatous cells occupy the region of the hypodermis; parenchymatous cells occupy the ground meristem. The primary growth phase reveals 3 vascular traces with no rib bundle wings in both growth phases (plates 1 and 2). On the other hand, the mid-rib of *S. nigrum* was similar to that of *S. melongena*. The mid rib of *S. melongena* is made of a layer of cells in the epidermis the cell and tissue arrangements and is similar in mid-rib of both plants except that there are 2 to 4 rib bundle wings present in the mid rib of *S. melongena*. Stem anatomy has an epicycle of many layers of cells below the endodermis

(inner-most part of the cortex) and large pith occupied by collenchymatous cells (plates 3 and 4). Also, the root anatomy of *S. melongena* revealed epiblema made of one layer. The vascular bundles have radial symmetry (plates 5 and 6).

Relatively, the mid-rib of *S. nigrum* showed numerous simple multicellular trichomes on the epidermal layer made of a roll cells. The hypodermis is made of few layers of thick wall cells termed collenchymas, the vest of the general cortex is composed of parenchymatous cells which are larger and made of this wall. Moreover, the mid rib of *S. melongena* has the same pattern of cell arrangement as in *S. melongena* expect that there are less tanniferous cells than the former.

On the other hand, table 1 showed mineral contents respectively. Selenium content showed significant values from  $655 \pm 55.0b$  to  $1030.0 \pm 10.01$  Mg/100ml. Calcium content ranged from  $387.33 \pm 53.00$  to  $873.33 \pm 16.67$  mg/100ml in both *S. melongena* and *S. nigrum* respectively. These values are higher than the values reported for some selected vegetable leaves in Nigeria, such as *Amaranthus hybridus*, *Hibiscus sabdariffa* and *Telfaria occidentalis* (Asaolu *et al.*, 2012) Potassium content ranged from  $2.26 \pm 0.55$  to  $4.90 \pm 1.71$  mg/100ml for the two species. The values were lower when compared with standard dietary allowance (RDA). The magnesium content ranged from  $29.40 \pm 0.40$  to  $44.45 \pm 0.89$ mg/100ml. the values obtained in these studies are low to meet the recommended daily allowance (RDA) of 400mg/day for men, women of 19 to 39 years old (Food and Nutrition Board, 1997).

More so, the iron content varies from  $36.86 \pm 2.17$  to  $65.84 \pm 0.7$ mg/100ml in both plants. The values were significantly higher than the values reported for some other vegetables in Nigeria (Chinma and Igyor, 2007). Iron is however, a part of the haemoglobin (Hb), myoglobin, and Cytochromes (Chandra, 1990). The content of Zinc ranged from  $123.33 \pm 3.33$  to  $491.66 \pm 85.00$  mg/ml in both plants respectively and these were significantly higher when compared with the standard recommended dietary allowance (RDA)

The result of the vitamin composition of the two *Solanum* species studied is present in table 2. Vitamin A content ranged from  $54.99 \pm 2.23$  to  $94.66 \pm 3.22$  mg/100ml as found in both plants. Hence, vitamin A is important for normal vision, gene expression, growth and immune function by its maintenance of epithelial cell functions (Lukaski, 2004). *Solanum nigrum* had  $(3.18 \pm 0.0)$ mg/100ml of vitamin C in its leaves as compared to  $0.92 \pm 0.03$ mg/100ml found in the leaves of *Solanum melongena*. Vitamin C helps in the reduction of folic acid intermediates and the synthesis of cortisol. Its deficiency includes fragility to blood capillaries, gum decay, scurvy. Lastly, Vitamin E content varied from  $7.34 \pm 1.49$ mg/100ml to  $4.14 \pm 0.89$ mg/100ml in both plants. Vitamin E is a powerful antioxidant which helps to protect cells from damage by free radicals and to the formation and normal

function of red blood cell and muscles (Lukaski, 2004).

This study which spans through the anatomical, and mineral and vitamin analyses of *S. melongena* and *S. nigrum* revealed various features. Thus, the implication is that the two species are closely related and this justified their placement in the same genus *Solanum* while the slight difference between them supports their separation into different species. The result also indicated that the various parts of the two species contained adequate amount of vitamins and minerals for human consumption.

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