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Comparative Antimicrobial, Phytochemical, Nutritional And Gc-Ms Profiling Of Methanolic Extracts Of *Solanum* Sect. Melongena

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Abstract
There is need for investigation into the relationship between organic chemical contents and various taxa of plants that exist. This study was conducted to further establish the biological importance of Solanum section Melongena which is beyond consumption. The antimicrobial screening was done by agar well diffusion. Bioactive, proximate and mineral components analyses were done by various spectrometry methods. The result of the antimicrobial screening showed that the plant species inhibited the test bacterial and fungal isolates with Solanum Indicum and Solanum Erianthum having the highest inhibition against Staphylococcus aureus, Candida albicans and Saccharomyces cerevisae. Higher content of alkaloid, saponin, terpenoids and cardiac glycoside and lower quantity of phenol, tannins, flavonoids and phlobatannin were detected in the plants extracts. GC-MS results showed the presence of phytoconstituents which supports the antimicrobial potentials of the plants, especially that of S. erianthum and S.indicum. The varieties were found to possess nutritional values and mineral contents such as high concentrations of Ca, K and Mg. These results revealed that the plants beyond their nutritional values possess strong antimicrobial properties and health benefits which can be useful in phytopharmaceutical and nutritherapy conditions in humans.
Keywords: *Antimicrobial, Melongena, Phytopharmaceutical, Solanum, nutritherapy*

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1. INTRODUCTION

Plants are sources of the basic needs of both animals and humans such as clothing, shelter and food. Medicinal plants are prominent group of plants having great economic importance and due to the current global threat of microbial resistance to drugs, the search for new drugs from naturally occurring bioresoures like plants remains a serious global burden (Ananda, 2012). As advocated by The World Health Organization (WHO) in a bid to recognize the immense importance of herbal medicine to primary health care delivery, proper identification, sustainable exploitation, scientific development and appropriate utilization of herbal medicines is key (Newman and Cragg, 2007). The popularity of crude herbal resources are even on the increase in developed countries (Street and Prinsloo, 2013). Many studies have been carried out to document the compositional and phytocontituent makeup of both higher and lower plants (Dairo *et al*., 2016; Ekop, 2007; Femi-Adepoju *et al*., 2018a; Femi-Adepoju *et al*., 2018b). Ethnobotanical usage of different parts of the plant includes cure for diseases like diarrhoea, malaria, helminths, pneumonia, dermatomycoses, leprosy, syphilis etc. (Mohamed *et al*., 2009).

Solanum species belong to the family Solanaceae and the genus *Solanum* consists of over 1,000 species globally (Agoreyo *et al*., 2012). There are 25 representative species of *Solanum* in Nigeria which includes those domesticated with their fruits and leaves and are either eaten as vegetables or used in traditional medicine (Bonsu *et al*., 2008: Manoko and van der Weerden, 2004). They are commonly referred to as 'garden eggs' in Nigeria, known as 'igba' in Yoruba, 'afufa' or 'anara' in igbo and 'gauta' in hausa (Agoreyo *et al*., 2012). They form one of the major food and soup recipes and indigenous medicines that are either consumed cooked or raw (Edem *et al*., 2009), especially in the western and southern parts of Nigeria. Eggplants exist in different varieties and species with their fruits having varying shape, colour and size (Chinedu *et al*., 2011). *Solanum* species have indigenous popularity in folk usage and importance, which varies from weight reduction to treatment of several ailments including, skin infections, constipation and asthma. Various parts of these plants can be used in decoction for dealing with ailments such as leprosy, diabetes, asthenia, gonorrhoea, bronchitis, cholera, dysuria, dysentery and haemorrhoids. (Gill, 1992). These therapeutic properties have been linked to the production of some chemical substances such as ascorbic acid, fibre, α-chaconine, phenols, anthocyanin, and glycoalkaloids in the plants (Chinedu *et al*., 2011). Some of the other important bioactive phytochemical constituents are alkaloids, essential oils, flavonoids, tannins, terpenoid, saponins, phenolic compounds and many more (Edeoga *et al*., 2005).

These Phytochemicals produced by these plant species are believed to be responsible for their antimicrobial activities (Adepoju., 2020). In the last couple of years, Gas Chromatography-Mass Spectrometry (GC-MS) has been established as one of the major technological procedure for the profiling of secondary metabolites in both plant and non-plant species (Kell *et al*., 2005; *F*ernie *et al*., 2004). However, a detailed literature review has shown that so far, there are few published reports worldwide on the possible antimicrobial properties, phytochemical, biochemical and mineral components of *Solanum* species of the Melongena section. This study is therefore aimed to determine the antimicrobial properties, phytochemical, biochemical and mineral components of *S. dasyphyllum, S. indicum* , *S. torvum*, and *S. erianthum* in the Melongena section.

2. MATERIALS AND METHODS

2.1 Test Organisms

The microorganisms used in this study, *P. aureginosa, P. putida, B. cereus, K. pneumonia, B. subtilis, E. coli, S. aureus, A. niger. A. flavus, C. albicans, S. cerevisiae* were clinical isolates obtained from the Department of Microbiology, University of Ilorin Teaching Hospital (UITH), Ilorin, Kwara state, Nigeria.

2.2 Plant Collection and Identification

Seed samples of *S. dasyphyllum, S. indicum* , *S. torvum*, and *S. erianthum* were collected from National Centre for Genetic Resources and Biotechnology, Ibadan, Oyo State, Nigeria. The seeds were regrown at the Botanical gardens, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. At plant maturity, samples were identified macroscopically and confirmed at the herbarium unit of the same university. The fresh leaf samples of each species were air-dried at room temperature for about seven days, after which sterile mortar and pestle was used in grinding them into fine powder and kept in separate, well-labelled plastic containers until further use at room temperature.

2.3 Preparation of Methanolic Extracts

Ten grams (10 g) of each of the powdery plant leaves were soaked into 100 mL of the solvent (methanol) in different airtight sterile jars at room temperature and kept on a shaker (at 90 rpm) with uniform shaking for 24 hr after which the solvents containing the extracts were decanted, filtered with a muslin cloth initially and then with Whatman no. 1 filter paper respectively. The solutions were heated at 55 °C on water bath for 5 min, sealed with the glass stopper and kept on the rotary shaker for 24 hr. After 24 hr, the solutions were concentrated under reduced pressure at 45 °C using the rotary evaporator to $1/10^{th}$ of the initial volume and finally dried at 55 °C in the oven. Dried extracts were weighed and stored at 4 °C in refrigerator for future use (Wu *et al*., 2011).

2.4 Sterility of Extracts

Each of the extracts was tested for growth of contaminants. This was done by making a serial dilution of 1g of each extract up to 10^{-1}. 20 µL of the diluents were aseptically inoculated on nutrient agar plates and incubated at 37 0C for 24 hr. The plates were observed for growth. Absence of microbial growth in the extract indicated their sterility. Sterile extracts were used to test for antimicrobial efficacy (Fadiji *et al*., 2018).

2.5 Antimicrobial Assay of the Extracts

Prepared sterile nutrient agar plate was inoculated with standardised organisms of 0.1mL of a day old culture. Glass spreader was used in spreading the inocula evenly on the surface of the agar and excesses were drained off. A sterile cork borer of 5mm diameters was used to make five (5) 'ditches' on the agar plates. The bacteria were inoculated into nutrient agar and fungi on PDA with 25mg mL^{-1} and 5mg mL^{-1} of the plant extracts was prepared from the stock solution, while methanol only was used as negative control, gentamicin and augmentin were used as positive control drugs. 0.5mL of each concentration of the extract was dispensed into each of the 'ditches' on the plates that are appropriately labeled . 0.5mL of methanol was also used. The plates were done in duplicates and left on the bench for few minutes for the extract to diffuse into the agar. Later, incubation was carried out at 37 ^{0}C $24hrs^{-1}$ for bacteria and 25^{0}C $72hrs^{-1}$ for fungi isolates. After incubation, the zone of clearance around each ditch was measured using a metric ruler by taking measurement of the zone of clearance around the ditch. The diameter of the cork borer was removed from the diameter of the zone of clearance and this made or represented the antibacterial and antifungal activities measured or diameter of the zone of inhibition.

2.6 Quantitative Determination of Phytochemical

The quantitative analysis of phenols, alkaloids, tannins, saponins and flavonoids were determined using standard method as applied by Krishnaiah *et al*. (2008). Total terpenoid content was determined by the method of Ghorai *et al* (2012). Cadiac glycoside and Phlobatannin were analyzed using that of Peng and Kobayasli (1995) method. Analysis of steroids and phlobatanins were also carried out (Sofowora, 1993).

2.7 Gas Chromatography-Mass Spectrophotometry (GC-MS) Analysis

GC-MS study was conducted on an Agilent 6890-5973N USA (Agilent Technologies; Hewlett-Packard Company 2850 Centerville Road Wilmington, DE 19808-1610 USA), with the gas chromatograph set with an HP1 capillary column TG-5MS polydimethylsiloxane (30 m length × 250 µm diameter × 0.25 µm film thickness) interfaced with Hewlett Packard (5973N) mass selective detector. Parameters were the initial temperature was 70˚C (0 min) and last temperature increased to 200˚C with final time 10 ˚C min^{-1} while, inlet temperature was 250 ˚C and split ratio was 10:1. MS quadruple and thermal aux temperatures were 150 and 285˚C, respectively. The MS scan range was 35–520 units and helium was used as the carrier gas with a flow rate of 1.0 mL min^{-1}. Compounds were identified and verified by comparing with gas chromatography-mass spectrum literature or data provided by the National Institute of Standards and Technology Mass Spectral database Wiley/NIST.1998.1 (Sparkman, 2005). To calculate the comparative yield of compounds, raw data was followed based on Gas Chromatography (GC) areas with a FID correction factor (Ahmed *et al*., 2019).

2.8 Proximate Analysis

The plant samples were air-dried and ground into powder. Ten grams were exhaustively processed for various parameters according to the methods described by the association of physical analytical chemists (AOAC, 1999). Biochemical analysis (dry matter/moisture, fat, protein, crude fibre, carbohydrates and mineral element/ash) of the investigated *Solanium* species (*S. dasyphyllum*, *S. indicum* , *S. torvum*, and *S. erianthum*) was carried out by standard methods. Percentage Dry matter/ moisture content was carried out Fat, Protein, Crude fibre (Asaolu *et al*., 2012; AOAC, 2000), Carbohydrate (AOAC, 2000) and Ash (Asaolu *et al*., 2012, (Ahmed *et al*., 2019) contents were also determined.

2.9 Mineral Element Composition

Estimation of mineral substances in dried grinded leaves was performed by using a NOVA400 atomic absorption spectrometer (ANALYTIK JENA AG, Jena, Germany) hollow cathode lamps andacetylene/air flame to measure absorbance. By using slits, wavelengths and lamp current; sodium (Na),potassium (K), manganese (Mn), magnesium (Mg), zinc (Zn), phosphorus (P), copper (Cu) and iron (Fe) were calculated. The analyzed results for Na, Mg, Ca, K, Zn, Cu and Fe contents were expressed in (ppm) (Ahmed, 2019; Asaolu *et al*., 2012).

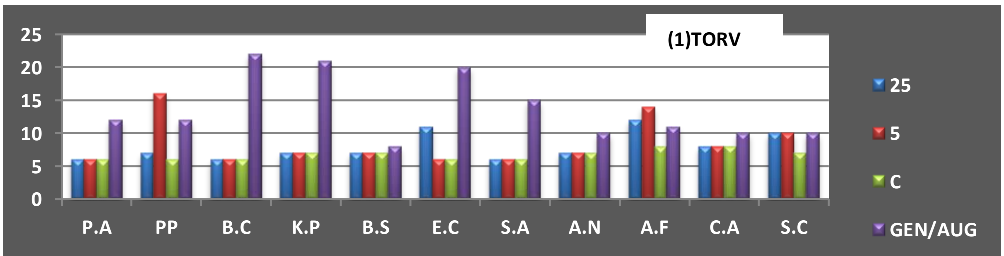
2.10 Statistical Analysis

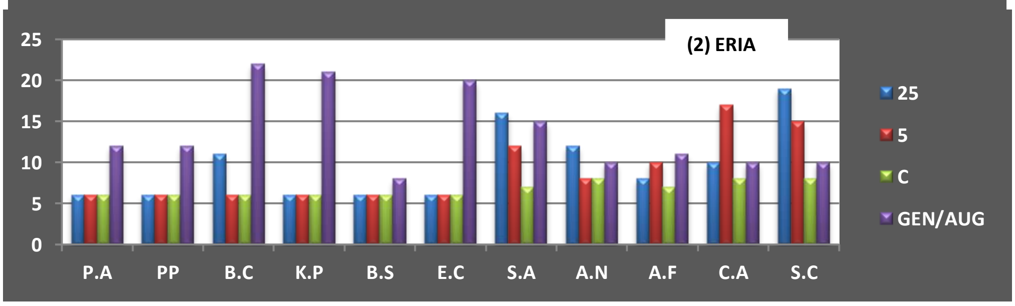
Data obtained were expressed in mean ± standard error of mean (SEM) and subjected to one-way ANOVA. Difference between groups was analyzed by considering P<0.05 statistical significance.

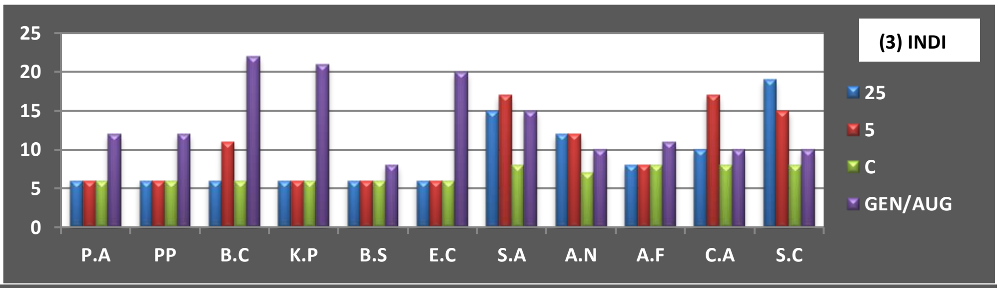
3. RESULTS

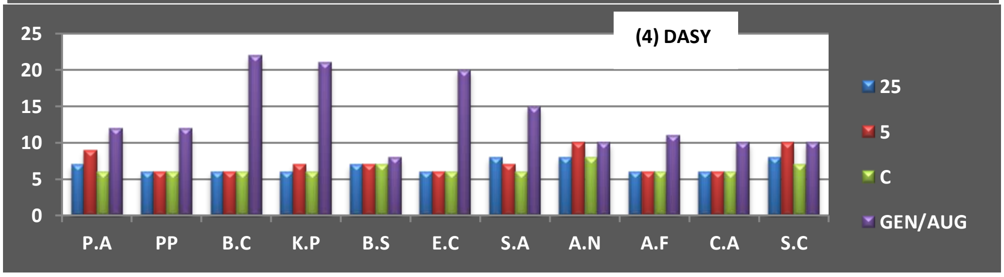
3.1 Antimicrobial Study

The screening for antimicrobial activity of the plant samples used in this study revealed that the plant extracts *S. dasyphyllum*(DASY), *S. indicum* (INDI), *S. torvum* (TORV) and *S. erianthum* (ERIA) had varying effects on the growth of the tested isolates namely, *P. aureginosa, P. putida, B. cereus, K. pneumonia, B. subtilis, E. coli, S. aureus, A. niger. A. flavus, C. albicans*and *S. cerevisiae*, ranging from 6-19 mm as presented in figures 1a-d. In fig. 1a,TORV extract at 5mg/ml was found to show higher activity against *P. Putida* and *A. Flavus* than the test antibiotics. In fig. 1b, 25mg of ERIA extract showed higher activity against *S. aureus,A. Niger* and *S. cerevisae* but at 5mg the higher activity in respect to the test antibiotics was recorded against *C. albicans*and *S. cerevisae*. In fig 1c, 5mg of INDI extract exhibit a higher antimicrobial activity against *S. aureus, C. albicans* and *S. cerevisae* but at 25mg equal antimicrobial activity was recordedagainst*S. aureus* when compared with the test antibiotics. In fig 1d, no onsiderably higher activity was recorded.Precisely, INDI and ERIA showed higher antimicrobial activity against the test isolates at the prepared concentrations than TORV and DASY. This study has revealed that the plant extracts have broad spectrum antimicrobial activities against the tested pathogenic clinical isolates. ERIA and INDI extracts proved to be the most effective antimicrobial agents while *S. aureus, A. niger* and *C. albicans* were the most susceptible test organisms. These activities might be attributed to the presence of different phytochemicals in the plants. Phytochemicals are derived from plants as compounds that reportedly have antimicrobial potency (Das, 2012), anticancer activities (Amadi *et al*., 2013), disease protective characteristics and extensive antioxidant capacities (Berma *et al*., 2013; Khan *et al*., 2013). In this study, alkaloid, saponin, terpenoids and cardiac glycosides were found to be present in high proportion in all the *Solanum* species. These have been reported to have medicinal properties like anti-inflammatory, antiviral, antioxidant, antimicrobial (Femi-Adepoju *et al*., 2018). The presence of the phytochemical constituents showed that the *S. melongena* varieties have medicinal property. Other compounds like flavonoids also have hypolipidemic effects, *ERIA* produced the highest level of flavonoid (0.64 ppm) in *ERIA*. *In vitro* studies have also shown that flavonoids have antiallergic, anti-inflammatory, antimicrobial and anticancer activities (Cushnie and Lamb, 2005; Dairo *et al*., 2016).









Figures1-4: Effect of Methanolic Extract of the Plants in the Section Melongena Against the Test Organism at Different Concentrations in mg/ml

3.2 Quantitative Phytochemical Composition of the Plant Extracts

The quantity of different phytochemical contents extracted from the leaves of DASY, INDI, TORV and ERIA is presented in table 1. TORV and DASY have higher alkaloid content than INDI and ERIA. The content of saponin, phenol and flavonoid recorded was highest in ERIA while that of the others were not significantly different, except for flavonoid being more in INDI than the other two. The quantity of tannin in DASY, INDI and TORV weresignificantly higher than that of ERIA. Terpenoid content was higher in TORV and ERIA while there wereno much significant differences in the quantity of cardiac glycoside and phlobatanin among the four plants. According to Femi-Adepoju *et al*. (2014), the mechanism of activity of plant extracts may not only be dependent on the compounds present, but also dependent on the particular pathogen, against which it has been tested. According to Adepoju *et al*. (2014), the part of plant used may also influence the degree of antimicrobial potential, since different parts of plant contain different degrees of bioactive components. Saponins and tannins have been found to exhibit cytotoxic and growth inhibition effects thereby are suitable as tumor inhibitors (Asl and Hossein, 2008).

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Table 1: Mean Quantities of some secondary metabolites (ppm) in the leaves of *Solanum* species studied.

Taxa	Alkaloid	Saponin	Phenol	Tannin	Flavonoid	Terpenoid	Cardiac Glycoside	Phlobatannin
DASY	0.71^{a}	0.84^{b}	0.12^{b}	0.44^{a}	0.40^{c}	0.83^{bc}	0.86^{a}	0.32^{b}
INDI	0.59^{b}	0.83^{b}	0.12^{b}	0.42^{a}	0.50^{b}	0.78^{c}	0.88^{a}	0.42^{a}
TORV	0.72^{a}	0.82^{b}	0.13^{b}	0.38^{a}	0.43^{c}	0.91^{a}	0.89^{a}	0.34^{ab}
ERIA	0.54^{b}	0.92^{a}	0.36^{a}	0.24^{b}	0.64^{a}	0.88^{ab}	0.89^{a}	0.39^{ab}

‘‘(DASY= *S. dasyphyllum*, INDI= *S. indicum* , TORV= *S. torvum*, ERIA =*S. erianthum*). Mean values in columns with different superscripts of alphabets are significantly different at P≤0.05 while those with the same alphabets are not significantly different at P≤0.05.‘‘

3.3 Gas Chromatography-Mass Spectrometry (GC-MS) Analysis

The presence of bioactive constituents in the methanolic extract of the four different *Solanum* sp was analyzed by GC-MS. Prime active components and peak area (%) were determined (Table 2). Different chemical compounds were revealed in the plant extracts. Table 2 shows that undecanoic acid, 10-methyl, methyl ester produced peaks only in DASY (10.14%) and INDI (7.89%). Compound 2-pentadecanone, 6, 10, 14-triemethyl was only recorded in TORV (2.47%). The highest peak for Hexadecanoic acid methyl ester was recorded in DASY (40.16%) followed by INDI, TORV AND ERIA respectively. Methyl stearate was found only in TORV with a peak of 8.36%. Dodecanoic acid methyl ester was only present in ERIA with a peak of 16.70%. DASY produced ethyl iso-allocholate and trans-13-octadecenoic acid methyl ester with a peak of 6.67% and 29.46% respectively. Eicosanoic acid methyl ester was only present in TORV with a low peak of 1.87%. It was also reported that, 11-Octadecenoic acid was only detected in TORV (23.13%), while 3',8,8'-Trimethoxy-3-piperidyl-2,2'-binaphthalene-1,1',4,4'-tetrone was only detected in TORV (2.74%) and Ethane, 1,2-bis (2-methyl-5-nitrophenyl) was detected in INDI (2.23%). It was also shown that Methyl tetradecanoate was only present in ERIA (5.79%). 13 octadecenoic acid, methyl ester was present in INDI and ERIA with peaks of 25.03% and 23.56% respectively. Also, 9,12-Octadecadienoic acid (Z, Z)-methyl ester was detected in TORV while Phytol has the highest peak in INDI (25.50%) followed by ERIA, TORV and DASY respectively. GC-MS analysis of the methanolic extracts of *Solanum* spp in the Melongena section showed different peaks which indicate the presence phytochemicals. These bioactive constituents that are present in high quantities have been reported to have profound therapeutic uses as follows; The fatty acid derivatives, hexadecanoic acid found in all the plant extracts have antimicrobial, anticancer, anti-inflammatory, antiandrogenic, antiarthritic and anticoronary among other uses (Femi-Adepoju *et al.*, 2018). A factor worthy of note is the presence of 13-Octadecenoic acid, methyl ester found only in ERIA andINDIwhich could be an indicator for their striking antimicrobial activities. Phytol on the other hand has anticancer, antioxidant, anti-inflammatory, diuretic, antitumor, chemopreventive, antimicrobial and use in vaccine formulation properties. This compound is found in both ERIA andINDI in higher propotion and could be associated with their higher antimicrobial potential. trans-13-octadecenoic acid methyl ester occurred only in DASY and is an anti-inflammatory, antiandrogenic, cancer preventive, dermatitigenic, flavor bioactive compound. 9,12-Octadecadienoic acid (Z,Z)-,methyl ester also have anti-inflammatory, hypocholesterolemic, cancer preventive, insectifuge, antiarthritic, hepatoprotective, antiandrogenic, nematicide, antihistaminic, antieczemic (Krishnamoorthy and Subramaniam, 2014). The bioactive compounds in the *S. melongena* varieties as reported by the GC-MS analysis could be used to justify the use of whole plants to cure certain ailments by traditional practitioners. However, further isolation, characterization and bioactivity study is required for other compounds which ethnobotanical uses have not been established yet.

Table 2: The percentage peak area values of some organic compounds quantified in the leaves of some Nigerian species of *Solanum*.

Name of Chemical Compound	Type of Compound	% Peak Area of Compounds			
		S. dasyphyllum	*S. indicum*	*S. torvum*	*S. erianthum*
Undecanoic acid, 10-methyl , methyl ester	Ester	10.14	7.89		
2-pentadecanone, 6, 10, 14-triemethyl	Alkanone			2.47	
Hexadecanoic acid methyl ester	Alkanoic Acid	40.16	29.76	42.2	31.92
Methyl stearate	Alkanoate			8.36	
Dodecanoic acid methyl ester	Ester				16.70
Ethyl iso-allocholate	Alkanoate	6.67			
trans-13-octadecenoic acid methyl ester	Ester	29.46			
Eicosanoic acid methyl ester	Ester			1.87	
11-Octadecenoic acid	Alkanoic acid			23.13	
3',8,8'-Trimethoxy-3-piperidyl-2,2'-binaphthalene-1,1',4,4'-tetrone	Alkanone			2.74	
Ethane, 1,2-bis(2-methyl-5-nitrophenyl)	Alkane		2.23		
Methyl tetradecanoate	Alkanoate				5.79
13-Octadecenoic acid, methyl ester	Ester		25.03		23.56
9,12-Octadecadienoic acid (Z,Z)-,methyl ester	Ester			7.89	
Phytol	Alcohol	0	25.5	11.35	12.97

3.4 Proximate Analysis

The results obtained from the four *Solanum* sp to proximate analysis indicates its richness in, crude fibre, ash, carbohydrate, crude protein, dry matter, and fats (Table 3). Significant (p <0.05) crude fibre was produced by INDI and DASY. The quantity of CHO, dry matter and fat was significantly highest in TORV followed by INDI,DASY and ERIA respectively. While ERIA and DASY showed the highest content of moisture followed by INDI and TORV, the quantity of protein was shown to be highest in ERIA but lowest in TORV. The case was shown however to be vice versa in the quantity of total ash between TORV and ERIA. The nutritional analysis of the four varieties of section Melongena used in this study showed generally low carbohydrate contents. These low carbohydrate and glucose levels makes them suitable for diabetic patients and individuals who are trying to reduce their weight. Fat levels obtained in the four species were a little bit higher than carbohydrate. Although this results obtained is not too different from earlier claim that *Solanum* specie reduce LDL/HDL ratio and increase HDL/LDL ratio in hypercholesterolemic rabbits (Igwe *et al*., 2003; Odetola *et al*., 2004). Generally, their fruits are recommended for individuals with increased serum lipid levels, high blood pressure and other ischemic heart diseases.

The quantity of protein in the four species of *Solanum* investigated was found to be high. Since these plant species can be eaten either raw or cooked, their protein contents could assist in boosting the proteins required from staple foods. Although the fibre contents of the four *Solanum* species were not high, these fibre contents together with the earlier low carbohydrate contents reported in these plant species are good in the management of diabetes (Agoreyo *et al*., 2012). The highest fibre content reported in *INDI* has supported the high edible potential of the fruits. Moisture content too is considerable higher in the two varieties that are not edible to man and lower in the varieties that produce edible fruits. This suggests the possibility of their being prone to infection by micro-organisms; however, the highly fibrous nature of the skin of their fruit makes it very strenuous for microorganisms to penetrate. This tends to give longer shelf life to these species *Solanum*, hence improving their post-harvest quality.

Table 3: Percentage Proximate Composition of the Species of *Solanum* Studied.

Taxa	% Cr. Fibre	% Cr. CHO	% Dry Matter	% Cr. Fat	% Moisture Content	% Cr. Protein	% Total Ash
DASY	16.94^a	6.33^c	2.221^c	12.041^c	37.52^a	32.41^b	16.111^b
INDI	17.04^a	7.21^b	2.461^b	12.691^b	36.00^b	32.40^b	15.461^c
TORV	14.42^c	8.90^a	3.211^a	12.824^a	33.10^c	32.10^c	16.242^a
ERIA	16.31^b	6.32^c	2.200^d	12.606^b	37.52^a	32.69^a	15.282^d

‘’(DASY= S. dasyphyllum, INDI= S. indicum , TORV= S. torvum, ERIA =S. erianthum). Mean values in columns with different superscripts of alphabets are significantly different at P≤0.05 while those with the same alphabets are not significantly different at P≤0.05’’.

3.5 Mineral Composition

The mineral composition was also determined, as indicated in Table 4, it was revealed that all *Solanum* sp. contained considerable amounts of minerals. Highest Mn was reported in DASY followed by ERIA, INDI and TORV respectively. Highest Zn was shown to be produced by TORV while the lowest was seen in DASY and ERIA. The highest Cu content was recorded by INDI, while significantly the same quantity was obtained for DASY and ERIA with TORV having the lowest content. Furthermore, high Na content was found in ERIA while the quantity of Na in INDI and DASY wassignificantly the same and lowest in TORV. The highest K content was produced in ERIA and DASY. Mg content was highest in INDI and DASY, followed by ERIA and lowest in TORV. Maximum Ca was recorded in DASY followed by, ERIA, DASY and INDI respectively. Also, the quantity of Fe was shown to be significantly highest in ERIA, followed by INDI, DASY and TORV. The highest P was significantly recorded in INDI followed by DASY, TORV and ERIA respectively.

Mineral analysis revealed that Ca, K and Fe which are important for the development of bone and production of haemoglobin respectively (Nelson and Cox, 2005; Helena, 2008) were considerably high in all the *Solanum sp* studied, though TORV and INDI are the only ones that produces edible fruits. However, Mg which plays a vital role in the activity of many enzymes and P that forms an important component of energy intermediates were highest in INDI (Vance *et al*., 2003). Zinc, which is often needed for the proper functioning of the reproductive system (Hambidge, 2006) was found present in the four *Solanum* species studied with the highest level found in *S. torvum*. Diets with low Na content as it is found in the *Solanum* species have been reported to be important in the prevention of high blood pressure (Lichtenstein *et al*., 2006) and high K has found in this study reportedly have a protective effect against excessive intake of Na. Therefore, the plant species understudied could contribute towards meeting some nutritional requirements of humans if used in adequate amounts and they can be considered as positive antimicrobial agents for protection against a range of pathogenic diseases. However, further studies are needed to explore their dietary potential against toxicity and also the possibility of their commercialization. Also, this study was not able to investigate the particular isolated and identified active principle, responsible for the antimicrobial activity in the *Solanum* melongena species.

Table 4: Mineral Element Composition (ppm) of the Species of *Solanum* Plants Studied.

Taxa	Mn	Zn	Cu	Na	K	Mg	Ca	Fe	P
DASY	0.333^{a}	0.500^{c}	0.444^{b}	1.700^{b}	27.421^{a}	13.211^{a}	27.402^{a}	0.341^{c}	0.892^{b}
INDI	0.321^{b}	0.519^{b}	0.492^{a}	1.701^{b}	27.110^{c}	13.214^{a}	27.091^{c}	0.349^{b}	0.941^{a}
TORV	0.201^{c}	0.556^{a}	0.400^{c}	1.628^{c}	27.000^{d}	13.001^{c}	26.941^{d}	0.302^{d}	0.361^{c}
ERIA	0.322^{b}	0.500^{c}	0.444^{b}	1.729^{a}	27.430^{a}	13.206^{b}	27.161^{b}	0.363^{a}	0.322^{d}

''(DASY= S. dasyphyllum, INDI= S. indicum , TORV= S. torvum, ERIA =S. erianthum). Mean values in columns with different superscripts of alphabets are significantly different at P≤0.05 while those with the same alphabets are not significantly different at P≤0.05''.

4. CONCLUSION

The findings of this study have been able to reveal that beyond the use of these plants (*S. Dasyphyllum*, *S. indicum*, *S. torvum* and *S. erianthum*) as everyday fruits and spices among folks, they have potential phytoconstituents and minerals that can help to improve on the overall health of all the individuals that feed on them. Therefore, it is recommended that these plants should be conciously included in daily diets for persons of all ages, as well as to be considered as potential pharmacological products.

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