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BIOACTIVES AND NUTRIENTS EVALUATION OF THE LEAVES AND FRUITS OF *SOLANUM MELONGENA*

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ABSTRACT

Leaves and fruits of garden egg (Solanum melongena) were analyzed for proximate analysis, mineral contents, vitamins, quantification and determination of phytochemicals at the School of Agriculture and Agricultural Technology Laboratory, Federal University of Technology Owerri, Imo State, Nigeria in October, 2018. Results of proximate analysis showed: moisture content (81.6 and 87.3) %, ash (0.86 and 0.52) %, fibre (3.2 and 1.3) %, protein (9.0 and 4.8) % fat, (1.4 and 0.7) % carbohydrate, (4.1 and 5.5) % for leaves and fruits respectively. Minerals were higher in leaves (Mg 135.2, Ca 89.6, K 45.4, Zn 1.9) g than fruit samples (Mg 65.8, Ca 13.4, K 39.3, Zn 0.16) g. On vitamins, leaves were also higher than the fruits (calcium (89.6, 13.4 mg/100) g, potassium (45.4, 39.3 mg/100) g, magnesium (135.2, 63.8 mg/100)g and zinc (1.9, 0.16 mg/100)g respectively. Both samples contained vitamins A and C with values of (4.95 mg/100, 1.15 mg/100) g and (13.03 mg/100, 5.52 mg/100) g for leaves and fruits respectively. The phytochemical composition results revealed the presence of bioactive compounds that are higher in leaves than fruits, such as alkaloids (2.50 and 0.08) %, flavonoid (1.30 and 1.10) %, phenols (0.033 and 0.009) % and tannin (0.18 and 0.03) % respectively. This study reveals the usefulness of Solanum melongena leaves and fruits for herbal and nutritional purposes, as they are rich in bioactive compounds, essential vitamins, minerals, and phytochemicals, making them suitable for treating high blood pressure, cancer, and other diseases.

Keywords: *Solanum melongena, Phytochemicals, Bioactives, Proximate analysis*
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INTRODUCTION

Plants provide food for man, animals and raw materials for many industrial products. Improved quality of food is important for healthy society (Story et al., 2010). Plants contain phytochemicals, which are produced by plants through primary and secondary metabolism, commonly found in fruits, vegetables, nuts, legumes and grains. They are recognized for their potential benefits for human health, used by plants for protection against potential threats from bacteria, viruses and fungi, when these fruits and vegetables are eaten by humans (Ohazurike et al., 2003) These defenses are passed along to them (humans) to fight off these threats to our health (Emeribe et al., 2016). Phytochemicals major research categories are carotenoids, and polyphenols such as phenolic acids, flavonoids, and stibenes (Harbone et al., 1980).

Solanum melongena like every coloured fruits and vegetables has one of the highest concentrations of phytochemicals which could help in the fight against disease such as cancer and heart diseases (USDA, 2017). Plants use phytochemicals to protect themselves against disease attack which may kill them. The natural accumulation of metabolites, vitamins and minerals in leaves help plants to overcome effects of pathogens. Local garden egg is one of the vegetable fruits that are rich in phytochemicals which have been used by humans indirectly when the fruit, which usually has bitter sweet taste, is eaten.

In Nigeria, garden egg is a highly valuable fruit eaten both raw and cooked. The fruits are usually harvested while still green before the fruit become red (ripens). It has a bitter sweet taste which is due to high level of saponin. The browning of garden egg flesh, when cut open, is due to the oxidation of polyphenols especially chlorogenic acid which is the most abundant phenolic compound. The red colour, it acquires at maturity is due to high carotene content (USDA, 2017). It is classified as a berry which contains many small edible seeds which have mild bitter taste (ARS, 2014). The fruit is less than 3cm in diameter and are roundish or egg-shaped, glossy, greenish with a meaty texture with flesh, where the tiny seeds are embedded. (Tsao & Lo, 2006). The fruit and leaves are used for preparation of various African dishes and h erbal remedies due to its rich bioactive nutrients. Hence, the fruit and leaves can be eaten raw or cooked, or used for the preparation of African salad, as well as cure for anaemia, indigestion, as effective diet of vegetarians, high blood pressure and diabetes (USDA, 2017).

In 2016, Garden egg production globally was 51.3 million tons. China produced over 62% alone, India 24.5%, Egypt 1.19 %, Turkey 0.55 %, Iran 0.5 % etc (FAO, 2016). In recent time, research has proven garden egg to be a multipurpose plant with acceptable nutritional value as food products and source of medicinal raw materials as well as contributing directly to food security and supplementary house hold income for all small and medium scale farmers. Garden egg is a vegetable with unique health benefits, helps build strong bones and prevent osteoporosis, ready cure for anaemia, high blood pressure, improves cardiovascular health, helps bowl movement, good for weight loss and protects infants from birth defects (Organic Information, 2018)

Garden egg is rich in calcium, a crucial mineral in regulating blood pressure and cholesterol levels and in maintaining heart health (USDA, 2017). Magnesium is important during enzyme catalyzed reactions for normal heart and brain health. The magnesium mineral is localized in the fruit. Iron, the very content of the green leaves of garden eggs is a bio-active phyto-chemical for formation of red blood cells and transporting oxygen and also regulate growth and supports the immune system.

Vegetables and fruits are cheap sources of phytochemicals and vitamins and *Solanum melongena* has been known to contain phytochemicals such as reservational and plant steroids which help lower cholesterol. Phytochemicals and vitamins are very important in agriculture because they help plants fight diseases and predators so as to survive and produce food with many benefits, when man consumes the plants containing these phytochemicals and vitamins by protection they provide. For instance, non-digestible dietary fibre from plants foods are phytochemicals with

approved health claims for the reduction of some types of cancer and coronary heart diseases (United States Food and Drug Admin, 2017).

Eggplants contain important phyto-nutrients many of which have antioxidant which slow the growth of breast and prostate cancer (American Cancer Society, 2016). Phytochemicals include alkaloids, flavonoids, tannins, and phenols. Alkaloids have been defined as naturally occurring chemical compounds containing basic nitrogen atoms in addition to carbon, hydrogen and nitrogen. They also contain oxygen, sulphur etc. Most alkaloid function is in protection of plants against parasitism and predation and regulation of plant growth and treatment of cancer (Kitacoop & Machdol, 2014).

Flavonoids have been defined as a group of plant metabolites thought to provide health benefits through cell signaling pathways and antioxidant effects. Flavonoids are bioactive plant chemicals found in fruits and vegetables of garden eggs. They are the largest group of phyto nutrients comprising more than 6000 types. Flavonoid is anti-inflammatory and anti-oxidant and is hoped as remedy for neurone generative disease like Alzhelmers and parkinsons. Plants like garden eggs contain reasonable amount of flavonoids. However cooking and stirring is known to change flavonoid make up in fruits and vegetables (Letenner et al., 2007).

Tannins are defined as astringent poly phenolic biomolecule that binds to and precipitates protein and various other organic compounds including amino acids and alkaloids. Tannins occur in plants and help plants protect itself from predation and pesticides and also regulate its growth (Thorington & Farrel, 2006).

Phenols also called phenolics are class of chemical compounds made up of hydroxyl (OH) and an aromatic hydrocarbon group. Carbolic acid (C_6H_5) is one of the simplest classes of phenol. The two classes of phenolic compounds are simple phenols units in the molecule (Robbins, 2003). Like alcohols, phenols have unique properties such as higher acidities due to the aromatic wings tight coupling with oxygen and hydrogen. The acidity of the aphetic alcohols and carboxylic acids is often between 10 and 12, the loss of hydrogen cation (H^+) from the hydroxyl group of phenol transforms it to phenoxide and phenolates (Klepack et al., 2011). In response to ecological pressures, such as pathogen and insect attack, some organisms synthesize phenolic compounds. Phenols are compounds in plants that give efficiency to plants use in traditional medicine and some have germicidal effects for disinfectants. Others that have estrogenic or endocrine disrupting activity are used in birth control. They also play important roles in plants development especially lignin and pigment biosynthesis and also provide structural integrity and scaffolding support to plants, and defense against predators especially herbivores (Talcott & Howard, 1999). Based on these aforementioned reasons, therefore, this study was specially designed to quantify the bioactive, minerals and nutrient contents of the leaves and fruits of *Solanum melongena* as a basis to advising the traditional medicine practitioners, herb users, herb sellers, health institutions and farmers on the health and nutritional importance of *Solanum melongena*.

MATERIALS AND METHODS

STUDY LOCATION

The planting of seedlings of *Solanum melongena* was carried out at Imo State University Teaching and Research Farm, Owerri, located on latitude 50^0N and 60^0N and longitudes 65^0E and 70^0E in the rainforest zone of South eastern Nigeria. Annual average rainfall is between 2500mm and 3000mm distributed between March-October and relative humidity of 75% (NIMET, 2014).

Preparation of plant materials

The leaves and fruits of *Solanum melongena* were obtained from the experimental plot located at Teaching and Research Farm of Imo State University, Owerri.The fresh leaves and fruits of garden egg at maturity were harvested and sent to School of Agriculture and Agricultural Technology Laboratory, Federal University of Technology Owerri for proximate, phytochemicals, minerals and vitamins determination.

Proximate analysis

In many food laboratories, most of the routine work comprises methods of proximate analysis. The main compositional components of interest are moisture, fat, protein and ash, available and unavailable carbohydrates.

Moisture Content

Drying methods: These involve the measurement of the mass lost due to the evaporation of water at or near the boiling point. Although such methods are frequently used as they can give accurate results when considered on a comparative basis, it should be borne in mind that the value obtained may not be a true measure of the water content of the sample. For example, volatile oil may be lost at drying temperatures such as 100^{0c}. The loss in mass may also depend on other factors, including particular size and mass of sample used type of dish and temperature variations in the oven from shelf to shelf. Ovens which are mechanically ventilated by means of an internal fan giving more consistent results and an increased rate of drying.

Procedure: Wash and dry the container in the oven. Transfer it to desicator, weigh the container. Weigh 2g of the sample. Dry in the oven at a temperature of 105^{0c} for some time, reweigh the container and sample, take back to the oven and dry, put in the desicator and weigh again. This process continues until a consistent result is obtained.

Calculation: % moisture content $= \frac{W_1 - W_2}{} \times \frac{100}{}$

Where

W_1 =Mass of container + sample before drying

W_2 = Mass of container + sample after drying

W = Mass of container

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Ash Content

The ash content of a material is the residue remaining after ignition at 25^{0C} for 3hours or longer to burn off all the organic matter or carbon. It is a measure of mineral content in the sample but is not necessarily quantitatively equal to them as there may be losses due to volatilization. The ash content or figure can be regarded as a general measure of quality.

Procedure: Wash and dry a silica (or platinum) dish or a crucible and cool in desicator. Weigh the crucible. Weigh 2g of the sample into the crucible. Place the crucible and contents in the muffle furnace. Regulate the temperature at $575 + 25^0$ until it is carbonized. Calculate until back particles are no more. Switch off the furnace and allow to cool somewhat, then place the crucible and content in a desicator and weigh.

Calculation:

$$\% \text{ Ash Content} \quad \frac{(W_3 - W_1}{(W_2 - W_1} \times \frac{100)}{1)}$$

Where;

W_1 = Mass of crucible

W_2 = Mass of crucible + Sample before ignition

W_3 = Mass of crucible Ash after ignition

$W_2 - W_1$ = Mass of sample taken for ignition

Crude Fibre

Crude fibre is the combustible organic residue that is left after other biomolecules like proteins have been removed by successive treatments with boiling acid and alkalis, alcohols and ether. This empirical treatment provides a crude fibre consisting largely of the cellulose content together with a proportion of the lignin and hemicelluloses content of the sample. The amounts of these substances in the crude fibre will vary with the condition employed so for consistent results a standardized procedure must be rigidly followed.

Procedure: Weigh out about 2.00g of the sample and place in a hot 200ml of 1.25% H_2S0_4 and boil for 30mins. Filter through a buckner funnel equipped with muslin cloth and held firm with elastic band. Make the funnel equipment hot by pouring boiling water on to it. Filter the hot acid sample solution. Wash the residue with boiling water to remove acid from it. Return the residue to 200ml boiling 1.25% Na0H and boil for 30mins. Filter and progressively wash with boiling water 1% HCl and boiling water to remove acid from it. Wash the residue twice with alcohol and three times with petroleum ether using small quantities. Drain the residue and transfer completely to a porcelain crucible and dry in the oven to a constant mass. Cool and weigh.

Incinerate at 600^0C for 2 hours in muffle furnace. Weigh the crucible and content after cooling in desicator. The loss on incineration is the mass of crude fibre.

Calculation

$$\% \text{ Crude fibre} \quad \frac{M_3 - W_4}{M_2 - M_1} \times 100$$

Where;

M_1 = Mass of crucible

M_2 = Mass of sample + crucible

M_3 = Mass of crucible + residue after drying

M_4 = Mass of crucible + ash after incineration.

Crude Fat (Ether Extract)

Procedure: Weigh out a known quantity of the sample into a thimble or filter paper carefully wrapped and tied with thread. Place the thimble or filter paper and contents in the soxhlet extractor column and extract for about 6 hours. When the solvent is clear in the column, the fat must have been extracted. Carefully remove the defatted sample and recover the solvent. Oven dry the flask and oil until all the solvent is gone. Reweigh the flask and its content.

Calculation

$$\% \text{ Crude fat} \quad \frac{M_2 - M_1}{M_1} x \frac{100}{1}$$

Where;

M_1 = Mass of flask

M_2 = Mass of flask + fat

M_3 = Mass of the sample

Phytochemical quantifiifaction

Tannin content was determined by folin-Denis spectrophotometric method as described by Pearson, (1976). A measured weight of the sample (1.0g) was dispersed in 10ml distilled water. The mixture was shaken for 30mins at a room temperature and filtered using Whatman filter paper (No.42). The residue was washed further with the distilled water until 100ml filtrate was obtained.An aliquot of the extract (2ml) was mixed with equal volume of folin-Dennis reagent in a 50ml volumetric flask. 2ml of saturated sodium carbonic solution was added. The mixture was added to the 50ml mark allowed to incubate for 98 minutes at room temperature. Meanwhile, a standard Tannin solution was prepared (with tannin acid) and diluted to a desired concentration. The diluted standard was treated as described for the sample. After incubation, the absorbance of

the standard and samples were measured at 760nm in a spectrophotometer. The tannin content was calculated using the formula below;

$$\% \text{ Tannins} = \frac{100}{W} \times \frac{au}{as} \times \frac{100}{W} \times \frac{vf}{va} \times D$$

Where;

Weight = Weight of sample

AU = Absorbance of the test sample

AS = Absorbance of standard solution

C = Concentration of the standard

D = Dilution factor where applicable

Vf = Total volume of filtrate

Va = Volume of filtrate analyzed

Total phenol was determined by the folin-ciocalteau spectrophotometer (AOAC, 1990). The total phenol was extracted in 200mg sample with 10ml concentrated methanol. The mixture was shaken for 30min at room temperature. The mixture was centrifuged at 5000xg for 15mins and the supernatant was decanted and used for spectrphotometric determination of polyphenol.A portion (1m) of the extract from each sample was treated with equal volume of folin-ciocalteau reagent followed by the addition of 2ml of 20% Na_2C0_4, solution. Meanwhile standard was also treated with the folin. Dennis reagent and Na_2C0_4 solution. The absorbance was measured in a spectrophotometer at 560nm. Measurement was made with a reagent blank at zero. The phenol content was calculated using the formula below.

$$\% \text{ Phenol} = \frac{100}{w} \times \frac{AU}{as} \times c \times \frac{Vf}{va} \times D$$

Where;

Weight = Weight of sample analyzed

AU = Absorbance of standard solution

AS = Absorbance of test sample

C = Concentration of the standard phytic acid solution

D = Dilution factor where applicable

Vf = Total volume of filtrate

Va = Volume of filtrate analyzed

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The method described by Harborne, (1973) was used to determine the flavonoid content of the samples. A measured weight (5g) of the processed sample was boiled in 100ml of 2MI-Icl solution for 40min. It was allowed to cool to room temperature before being filtered through Whatman filter paper (No.42) to obtain the extract.

$$\% \text{ Flavonoids} = \frac{\text{Weight of Residue (Flavonoid)}}{\text{Weight of sample}} \times \frac{100}{1}$$

The alkaline precipitation gravimetric method (Horborne, 1973) was used. A measured weight of each processed sample, was dispersed in 100ml of 16% acetic acid in ethanol solution. The mixture was shaken vigorously and allowed to stand for 4 hours at room temperature with shaking every 30min. At the end of this period, the mixture was filtered through Whitman filter paper (No. 42).The filtered extract was concentrated by evaporation, to a quarter of its original volume. The extract was treated will dropwise addition of concentrated ammonia solution to precipitate the alkaloids, ammonia was continuously added until it was in excess.

The precipitated alkaloid was filtered using Whitman filter No (2) after washing with 1% NH_I0H solution, the precipitated alkaloid was dried at 105^0c weighed after cooling in a dessicator. The alkaloid content was calculated as shown below;

$$\% \text{ Alkaloid} = \frac{(W_2 - W_1)}{\text{Weight of sample}} \times 100$$

Where;

W_1 = Weight of empty filter paper

W_2 = Weight of sample

Determination of vitamins

Vitamin A was determined by the method of Association of Vitamin Chemists (Kirk & Sawyer, 1998). Five grams (5.0g) of each sample was dispersed in 30a of absolute alcohol and 3ml of 50% potassium hydroxide solution was added to it and distilled under reflux for 30min. After cooling rapidly in running water, 30ml of distilled water was added to it and the mixture was transferred to a separation funnel. Three portions of 50mls of ether was used to wash the mixture thus extracting the Vitamin A. the lower layer (i.e the aqueous layer) was discarded while the Vitamin A extract was washed with 50ml distilled water taking care to avoid formation of emulsion.

The Vitamin A extract was evaporated to dryness and then dissolved in 10ml isoprophyl alcohol. Meanwhile, standard Vitamin A solution was prepared and diluted to a desired concentration using (isopropyl alcohol). The absorbance of both the sample extract and the standard were measured in a spectrophotometer at 325mm. The Vitamin A content was calculated as shown below:

Vitamin A (mg/100g)

$$= \frac{100}{w} \times \frac{au}{as} \times C$$

Where;

W = Weight of sample

au = Absorbance of sample extract

as = Absorbance of standard vitamin A solution

C = Concentration (iu/ml) of standard vitamin A solution

Vitamin C was determined by the Barakate titrimetric method. A measured weight (20grams) of the sample was homogenized in 10ml of 6% TCA/EDTA solution. The homogenate was filtered with Whatman filter paper (No 42). The residue was washed with the extracted solution until the filtrate was 100ml in the flask.20ml of the filtrate was mixed with 10ml of 30% potassium iodate solution in a flask. 20ml of 1% starch solution was added to it as indicator and it was titrated against 0.01m copper sulphate solution. A reagent blank was also filtrated using 20 ml of distilled water in place of the extract.The Vitamin C content was calculated on the Lasis that 1ml 0.01M $CuSO_4$ solution = 0.88g Vitamin C

The formula is written in this form

$$\text{Vitamin C mg/100g} = \left\{ \frac{100}{W} \times 0.88 \times \frac{vf}{va} \quad T - B \right\}$$

Therefore;

BLK = Titre value of the reagent blank

Where;

w = weight of sample in gram

vf = Total filtrate volume

va = Volume of filtrate analyzed

T = Titrate value of sample

B = Titre value of the Blank

RESULTS

PROXIMATE ANALYSIS

The proximate analysis of *Solanum melongena* leaf and fruit are shown in Table 1. *Solanum melongena*fruit contains percentage moisture content (87.3), % ash (0.86) % fibre (1.3), %

protein content (4.8), fat (1.4) and % carbohydrate (5.5) while the leaf contained % ash (0.52), % fibre (1.3), % protein content (4.8), % fat (0.7), % carbohydrate respectively.The proximate analyses of leaf and fruit of *S.m* are as shown in the Table 1 are (89.6g), potassium (45.4g), zinc (1.9g), while fruit contained magnesium (65.8g), calcium (13.4g), potassium (39.3g), zinc (0.16g) respectively. On vitamins, leaf contained vitamin A (4.95 mg/100g) and vitamin C (13.03 mg/100g) while the fruit contained vitamin A (1.15 mg/100g) and vitamin C (5.52 $mg^{100}g$) respectively. The concentration of % alkaloid in *Solanum melongena* leaf was (2.50) while the fruit contained alkaloid (0.08), % flavonaoid (1.10) and % phenol (0.009) and tannin (0.03) respectively.

The result of phytochemical quantification of leaf of *Solanum melongena* were (alkaloids 2.50, flavonoids 1.30, phenol 0.009, tannin 0.03) % while fruit were (alkaloids 0.08, flavonoids 1.10, phenol 0.009, tannin 0.03)%. *Solanum melongena* leaf contained magnesium (135.2), calcium (89.6), potassium (45.4), zinc (1.9), while *Solanum melongena* fruit contained magnesium (65.8), calcium (13.4), potassium (39.3), zinc (0.16) respectively.

The results of minerals determination of the leaf and fruit of *Solanum melongena* are as shown in Table 2.

Phytochemical Quantification

The concentration of % alkaloid in *Solanum melongena* leaf was (2.50) while the fruit contained alkaloid (0.08), % flavonaoid (1.10) and % phenol (0.009) and tannin (0.03) respectively. The result of phytochemical quantification of leaf and fruit of *Solanum melongena* are as shown in Table 3.In the case of vitamins, *Solanum melongena* leaf contained vitamin A (4.95mg/100g) and vitamin C (13.03 mg/100g) while the fruit contained vitamin a (1.15 mg/100g) and vitamin C (5.52 mg/100g) respectively. This is as shown in Table 4.

DISCUSSION

Analysis of proximate composition provides information on the basic chemical composition of the plant samples. The compositions are moisture content, ash, crude fibre, protein content, crude fat, and carbohydrate. These components are crucial to the assessment of the nutritive quality of the leaf and fruit of the plant being analyzed. Table 1 showed the proximate analysis of the leaves and fruits of *Solanum melongena*. The moisture content of garden egg fruit was higher with a value of 87.31% to the leaf sample with 81.6%. The moisture content of food or its processed product gives an indication of its freshness and shelf-life. The moisture content of a fresh fruit is related to its dry matter content.

Crude fat determines the free fatty lipids of a product. This property can be used as the basis in determining processing temperatures as well as anti-oxidation which can lead to rancidity (affect flavor of food). The fat contents of leaf differ with the garden egg fruit having 1.4% while the leaves have 0.7%. The fat contents are low and will enhance the storage life of the sample due to

the reduction in chance of developing rancid flavor and may not be good source of fat soluble vitamins nor can contribute significantly to energy content of seeds that can be prepared with the leaf samples.

The ash content can prove as estimate of the quality of the product. The values of the ash in garden egg leaf 0.86% were higher as compared to the fruit sample with 0.52%. The high values of the ash were indicative of high mineral content of the samples. Crude fibre measures the cellulose, hemicelluloses and lignin content of food. Lignin comprises polymers of phenolic acid. The garden egg leaf was high 3.2%. High fibre content in diets have been reported to result in increased removal of carcinogens, potential mutagens, steroids, bill acids and xenobiotics by binding or absorbing to dietary fibre components and be rapidly excreted, hence these samples will have health providing benefits for the ruminants.

The protein content was 9.00% in the garden egg leaf and 5.00% on the fruit; protein is an essential component of diet needed for survival of humans. Their basic function in nutrition is to supply adequate amount required amino-acids. Protein deficiency causes growth retardation, muscle wasting, and abnormal swelling of the belly and collection of fluids in the body.The carbohydrates content of the garden egg leaf was 4.1% and the fruit was 5.5% which is low indicating that it is not an energy giving plant. The low carbohydrate could be attributed to the high fibre, ash and protein plant.

The results of mineral determination were shown in Table 2. Analyses of the mineral contents showed that there were variations from the samples (leaves and fruits) in the content of calcium (89.6-13.4 mg/100g), potassium (45.4-39.3mg/100g), magnesium (135.2-65.8mg/100g), and zinc (1.9-0.66 mg /100 g).The calcium and zinc that are required for bone development and hemoglobin production respectively were higher on the garden egg fruit sample with value 89.6mg/100g, and 1.9 mg/100g. The magnesium content was higher in garden leaf (135.2 mg/100g) when compared to the fruit (65.8mg/100g), magnesium helps in energy metabolism, protein synthesis, RNA and DNA synthesis and maintenance of biochemical potential of nerve tissue.

Potassium is the principle contained in the intracellular fluid functions in acid base balance, regulation of osmotic pressure condition of nerve impulse, muscle contraction particularly the cardiac muscle, cell membrane function and Na^{+}/k^{+}. Potassium deficiency affects the collecting tissues of the kidney, resulting in the inability to concentrate urine and also cause anti rational of gastric recreations and intestine motility.The phytochemical components are responsible for both pharmacological and anti-toxic activities of plants. This study revealed the presence of various medicinal importance of phytochemical in the leaf and fruit samples. This is in agreement with (USDA, 2017) which stated that phytochemicals can help to fight threats to our health.

Alkaloids are basic natural products occurring primarily in plants, pure isolated alkaloids and their derivatives are used medicinally but high doses of it can be harmful to the body organs.

This supports the works of Kiltakop and Malidol, (2014) that opined that alkaloids are known to have pharmacological activities against cancer in humans.

Tannins have anti-bacterial potentials due to their ability to react with protein to form stable water soluble compound thereby killing the macro organism by directly damaging its cells membrane. The tannin composition of the sample ranged from (0.18%) leaf to 0.03 fruit. Tannins are potent astringents, the low tannin content in the leaf and fruit sample is not enough to constitute human poison (Thorington & Farrel, 2006). The flavonoid quantification of the leaf and fruit samples ranged from 1.30% and 1.10% respectively. These mean values are slightly varied. The results are low but are of good values to promote effect which include anti-allergic, anti-oxidant, anti-inflammatory, anti-cancer and anti-viral effect (USDA, 2017).

Phenols play important roles in plants development especially lignin and pigment biosynthesis and also provide structural integrity and scaffolding support to plants, and defense against predators especially herbivores. Phenols have germicidal effects and are useful in formation of disinfectants (Robbins, 2003; Talkott & Howard, 1999).

Vitamins determination showed the presence of B-carotene (Vitamin A) precursor in the plant (leaf and fruit samples) which apart from helping in growth, also promote resistance to disease, decays, aging presides over the health of the eyes, skin, nails and hair.The vitamin C level of the plant was comparably lower than (33mg/100g, USA, 2009) and Borecole (Brassica Olercea), (23.43mg/100g). Vitamin C (ascorbic acid) helps in the health of lungs and bronchial, teeth and jaws, bones and joints. It prevents the free damage that triggers the inflammatory cascade, and associated with reduced severity of inflammatory conditions such as asthma, osteoarthritis and rheumatoid arthritis and is used in herbal medicine for the treatment of common cold and other disease like prostate cancer. The vitamin C was observed to have the highest value of vitamins both the leaf and the fruit.

CONCLUSION

This study which was based on laboratory tests has identified the usefulness of *Solanum melongena* leaves and fruits for herbal and nutritional purposes. *Solanum melongena* leaves and fruits are rich in bioactive compounds. These compounds are sources or ingredients for industrial drug formulation. As rich source of phytochemicals together with presence of the essential vitamins and minerals (A and C), (Ca, K, Mg, Zn), the leaves and fruits of *Solanum melongena* can be used for patients suffering from high blood pressure, anti-cancer and treatment of some diseases. The study therefore makes the following recommendations that phytochemicals gotten from the leaves and fruits of *Solanum melongena* can be recommended to increase the shelf-life of plant produce through control of pests and diseases. Extracts from the leaves and fruits can be recommended for the preparation of syrups and infusion in traditional medicine as a remedy for improvement of brain function and aids in digestion. *Solanum melongena* leaves are also recommended to be taken more than the fruits because of its high content of bioactives as shown in all the analyses/laboratory tests.

REFERENCES

Agricultural Research Service (ARS), (2014). Solanum melongena (Terruplasm Resources information Network) (GRIN) Agricultural Research Service (ARS). United States Department of Agriculture (USDA) Retrieved 20, November, 2014.

American Cancer Society (2016). Common Questions about diet and cancer. Retrieved 8 January 2017.

AOAC, (2018). Association of Organic and Analytical Chemistry, 16 (5), National Bulletin, 23rd January 2018.

Emeribe, E., Ohazurike, N., & Okorie, H. (2016). Pesticidal potentials of seed extracts of Black Pepper (Piper nigrum L) in the control of Maize grain weevil (Sitophilus zeamais Mots) in storage. *Journal of Agriculture and Food Sciences*, *13*(2), 1. https://doi.org/10.4314/jafs.v13i2.1

FAO (2016). Agricultural Production Reports on Egg Plant.

Harborne, J. B. (1973). *Phytochemical Methods: A guide to modern techniques of plant analysis*. https://www.springer.com/cda/content/document/productFlyer/productFlyer_978-0-412-57260-9.pdf?SGWID=0-0-1297-33550746-0

Harborne, J.B. (1980). Plant phenolics. In *Springer eBooks* (pp. 329–402). https://doi.org/10.1007/978-3-642-67360-3_14

Story, E. N., Kopec, R. E., Schwartz, S. J., & Harris, G. K. (2010). An update on the health effects of tomato lycopene. *Annual Review of Food Science and Technology*, *1*(1), 189–210. https://doi.org/10.1146/annurev.food.102308.124120

Thorington, R.W., & Farrel, K.E. (2006). Squirrels, the animal answer guide. Baltimore: John Hopkins University Press. Pg 1911.

Kittakoop, P., Mahidol, C., & Ruchirawat, S. (2013). Alkaloids as important scaffolds in therapeutic drugs for the treatments of cancer, tuberculosis, and smoking cessation. *Current Topics in Medicinal Chemistry*, *14*(2), 239–252. https://doi.org/10.2174/15680266136661312161050 49

Kirk & Sawyer (1998). Taxonomy description of species classifications and other botanical details pertinent to Solanum genus.

Klepack, J. (2011). Phenolic compounds as cultivar and variety distinguishing factors in some plant products. *Plant Food Human Nurtition*, *66*(1), 64-69. https://doi.org/10.1007/s11130-010-0205-1

Letenneur, L., Proust-Lima, C., Le Gouge, A., Dartigues, J.F., & Barberger-Gateau, P. (2007). Flavonoid intake and cognitive decline over a 10-year period. American Journal of Epidemiology, 165 (12), 1364-1371.

NIMET (2014). Nigeria Meteorological Institute. Federal Office of Statistics (FOS) Building, Maitama, Abuja, Nigeria.

Ohazuruike, N.C., Onuh, M. O., & Emeribe, E. O. (2003). The use of seed extract of the physic Nut (Jatropha curcas L.) in the control of maize weevil (Sitophilus zeamais Mots) in stored maize grain (Zea mays L.) *Global Journal of Agricultural Sciences, 2*(2), 86-88. https://doi.org/10.4314/gjass.v2i2.2212

Organic Information (2018).Edmundo Garcia Jr. (9 March, 2018). Warning letter, Carol Bond Health Foods: US Food and Drug Administration. Retrieved 15h April, 2018.

Pearson, D, (1976). The Chemical Analysis of Food. 7th End, Churchhill Living Stone, London ISBN 978-2-910810-375.

Robbins, R.J. (2003). Phenolic Acids in Foods: An Overview of Analytical Methodology. *Journal of Agriculture and Food Chemistry, 51,* 2866-2887. https://doi.org/10.1021/jf026182t

Talkolt, S.T., & Howard, I.R. (1999). Phenolic Auto Oxidation is responsible for Colour Degradation in Processed Carrot Puree. *Journal of Agricultural Food Chemistry 47*(5), 2109-2115. https://doi.org/10.1021/jf981134n

Tsao & Lo, (2006). Vegetables, types and "Biology" Hand book of Food Science, Technology and Engineering. CRC Press. ISBN 1-57444- 551-0.

USDA, (2017). United State Food and Drugs Administration. Health Claims: fibre containing grain products, fruits and vegetables and cancer title 21: Food and Drug Subpart E-101. 76" US Food and Drug Administration 5.

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APPENDICES

Table 1:Proximate Analyses of *Solanum melongena* Leaf

Parameters	Leaf	Fruit
% Moisture content	81.6	87.3
% Ash	0.86	0.52
% Fibre	3.2	1.3
% Protein content	9.0	4.8
% Fat	1.4	0.7
% Carbohydrate	4.1	5.5

Table 2: Mineral Determination

Minerals	Leaf	Fruit
Potassium mg/kg	45.4g	39.3g
Calcium mg/kg	89.6g	13.4g
Magnesium mg/kg	135.2g	65.8g
Zinc mg/kg	1.9g	0.16g

Table 3: Phytochemical Quantification of *Solanum melongena* leaf

Phytochemicals	Leaf	Fruit
% Alkaloid	2.50	0.08
% Flavonoid	1.30	1.10
% Phenol	0.033	0.009
% Tannin	0.18	0.03

Table 4: Vitamins

Vitamins	Leaf	Fruit
Vitamin A	4.95	1.15