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Phytochemical, Nutritional and Trace Element of Some *Solanum* (Garden Egg)

[1]Henry, M.U., [1]Dogun, O., [1]Ogenyi, R.A., *[2]Obidola, S.M. and [2]Henry, U.I.

[1]Science Laboratory Technology Department, Federal College of Forestry, Jos – Plateau State.

[2]Crop Production Technology Department, Federal College of Forestry, Jos – Plateau State.

Abstract

Vegetables and fruits form some of the most important components of daily nutrition owing to their high mineral and vitamin contents which are essential for a balanced diet. This research work was carried out on the phytochemicals, proximate and trace element content of three varieties of garden egg which are *Solanum melongena* (*S. melongena*), *Solanum aethiopicum* (*S. aethiopicum*) and *Solanum macrocarpon* (*S. macrocarpon*). The egg plants were extracted and their phytochemical, proximate and trace element content carried out using standard procedures. The result showed that carbohydrates, flavonoids, terpenoids, steroids, anthraquinones, phenols, tannins and proteins were present in the three varieties of the eggplant. Saponin was only observed in *S. aethiopicum* but not in the other two varieties, while alkaloids were observed to be present in only *S. macrocarpon*. Cardiac glycosides, anthocyanin and phlobatanins were completely absent in the three varieties. The proximate composition showed that *S. melongena* contained percentage moisture content (52.23%), ash (23.10%), fibre (3.16%), fat (6.02%), protein (2.38%), carbohydrate (12.05%) while *S. aethiopicum* contained percentage moisture (59.05%), ash (17.49%), fibre (1.69%), fat (8.05%), protein (2.49%), carbohydrate (11.84%) and *S. macrocarpon* contained percentage moisture (57.68%), ash (22.71%), fibre (2.05%), fat (5.04%), protein (2.56%) and carbohydrate (10.40%). The trace element content for *S. melongena* showed magnesium (279.57), calcium (106.80), zinc (4.77), copper (0.88), iron (57.45), manganese (5.53) in parts per million (ppm) while *S. aethiopicum* contained Mg (258.16), Ca (76.29), Zn (5.55), Cu (1.18), Fe (49.49), Mn (5.43) in (ppm) and *S. macrocarpon* contained Mg (280.5), Ca (84.95), Zn (3.98), Cu (0.29), Fe (41.49) and Mn (3.44) in (ppm). The findings showed that the three eggplant varieties will serve as a good nutritional diet while *S. melongena* will supply more trace elements (Fe, Ca, and Mn) and total ash, fibre and carbohydrates. *S. aethiopicum* has alkaloids and more terpenoids and steroids and hence, will serve as a good medicinal component.

Keywords: Solanum, eggplant, proximate, phytochemicals, trace elements.
***Corresponding Author's email:** obidolabch@gmail.com, **Tel: +2348062719051**

Introduction

Garden eggs are tropical perennial plants that belong to the *Solanaceae* family. They are classified as vegetable and fruit plants and hence, their nutritional importance cannot be over emphasized (Chuku et al., 2020). Garden eggs are one of the most sought after fruits owing to their richness in nutritional and essential vitamins and minerals (Mandal, 2010).

It is ranked among the top ten vegetables in terms of antioxidant capacity due to the phenolic constituents such as caffeic acid and chlorogenic acid (5-0-caffeoyl quinic acid) (Clement et al., 2018). They are sometimes employed in traditional medicine for the treatment of many diseases. Garden eggs have been reported to aid digestion, relieve constipation, aid the fight against cancer, blood pressure and reduce cholesterol (Lekadou et al., 2019).

Solanum species (garden eggs) belong to the family of plants called *Solanaceae* with over 1,000 species worldwide (Bonsuko et al., 2000). They are commonly referred to as garden egg in English, while it is locally named in the three major tribes in Nigeria as *guata* by the Hausa tribe, *afufa* or *anara* by Igbo tribe and *igba* or *ikan* by the Yorubas. The fruit of the plant comes in a wide array of shapes, sizes and colors depending on the species (Wei et al., 2019). Garden eggs attain a height of 40 to 150 cm and may possess leaves that are coarsely lobed. The leaves are 5 to 10 cm wide and 10 to 20 cm long (Syfert et al., 2016).

Plant phytochemicals are natural compounds found in plants which are biologically active and perform medicinal functions in the body of animals. They are acquired by plants as defense and protective mechanisms against diseases, environmental hazards and pathogenic microorganisms (Khare et al., 2021). Phytochemicals are also known to contribute to the attractiveness of plants to insects and birds through their inherent flavour, scents and colour. They are found in different parts of plants varying from plant to plant and from the leaves, stem bark, stem, root bark, flowers, and fruits in terms of their concentrations. Phytochemicals perform different medicinal purposes, and they serve as antioxidants, antimicrobial, immune stimulation, decrease of platelet aggregation and modulation of hormone metabolism and anticancer property (Tabassum et al., 2022; Usman et al., 2022).

Chemical analysis of plant parts including the leaves, roots, stem bark, fruit or the flower reveals the amount of chemical constituents and the possible functions performed by such constituents. Proximate analysis, as well as profiling of the trace elements in some species of *Solanum* can provide some information about the nutritional differences in the different varieties (Odoh et al., 2018). Proximate composition consists of a series of analysis which reveals the crude protein, fat, carbohydrates, moisture content, fibre and the total ash contained in a sample (Khan et al., 2013). Trace elements form components of human diets in very little amount. As little as they may be, they partake in very important biochemical reactions. These trace elements are involved in important body functions such as carbohydrate, protein, lipid, amino acid and cholesterol metabolism, wound healing, connective tissues, hemopoiesis, antioxidant function, reproduction, and uric acid function (Wada, 2004).

Materials and Methods

Sample Collection and Preparation

Fresh samples of garden eggs were bought from Farin Gada Market in Jos North Local Government area of Plateau State. Three varieties were selected, and they include *S. melongena*, *S. macrocarpon* and *S. aethiopicum*. The samples were deposited to the herbarium of Federal College of Forestry, Jos where voucher number FHI-212396 (*S. melongena*), FHI-172194 (*S. macrocarpon*) and FHI-112798 (*S. aethiopicum*) were obtained. The samples were properly rinsed with distilled water and sliced into smaller pieces using a stainless-steel knife. It was air dried under room temperature (25^{o}C) and then pulverized using mortar and pestle into coarse powdered form and sieved using a mesh size of 250 microns.

Sample Extraction

Exactly 20 g of pulverized sample was percolated in 200 mL of distilled water in a 250 mL conical flask with constant shaking for 24 hours. The sample was then filtered with Whatman No. 1 filter paper. The filtrate was concentrated using lyophilizer (Model No: AIK-HFD-4 Hellog) to obtain crude extract.

Phytochemical Analysis

The crude extracts of the three eggplant varieties were subjected to qualitative phytochemical screening for identification of various classes of active chemical constituents such as tannins, saponins, cardiac glycosides, steroids, terpenoids, flavonoids, anthraquinones, proteins, alkaloids, carbohydrates, phenols, anthocyanins and phlobatannins. The phytochemical analysis was done according to the standard method by Sofowora (1993) and Trease and Evans (1985).

Proximate Analysis

Proximate components such as total carbohydrate, crude protein, moisture content, total ash, crude fiber, and crude fat were determined according to the Association of Official Analytical Chemist Method (AOAC). The protein content was determined by a conversion factor of 6.25 (AOAC, 2000).

Digestion of Garden Egg Samples for AAS

Exactly 1 g of each sample was weighed and put in a beaker. *Aqua regia* in the ratio of 1:3 was used for the digestion of the different garden egg samples. The digestion was carried out for 5 hours in a fume cupboard after which the solution was removed from the fume cupboard and allowed to cool. The solution was filtered using No. 42 filter paper and made up with distilled water to a volume of 50 cm^3. The filtrate was analyzed using the Atomic Absorption Spectrophotometer (AAS).

Trace Element Analysis

The trace elements were analyzed using Atomic Absorption Spectroscopy (AAS) (Model: 222-2000 20D) 55A atomic absorption spectrometer Agilent Technologies using the method of AOAC (1995). The trace elements determined include magnesium, calcium, copper, zinc, iron, and manganese. Three clean crucibles were properly dried and weighed after which 1.0 g of the samples was added. The crucibles were placed in a fume cupboard on a hot plate and the temperature increased until no smoke was noticed after which the sample was charred. They were placed in a muffled furnace and the temperature set at 2,500^{0}C and later gradually increased to 5,000^{0}C until complete ashing was achieved. The ash was heated up for 5 minutes between 80^{0}C – 100^{0}C after cooling from the initial torrid heating and the addition of 20 mL of 1N HCl. The samples were filtered, and the filtrates read using Atomic Absorption Spectrophotometer (AAS).

Statistical Analysis

The data obtained were subjected to one-way analysis of variance (ANOVA) using SPSS version 23 with Completely Randomized Design (CRD). Least Significant Difference (LSD) was used to separate the means and in the occurrence of statistical differences, Duncan Multiple Range Test (DMRT) was used to separate the means.

Results

Phytochemical Composition

Table 1: Phytochemical Composition of the Three Varieties of Garden Egg

Constituents	*S. melongena*	*S. macrocarpon*	*S. aethiopicum*
Carbohydrates	+	+	+
Saponins	-	-	+
Flavonoids	++	+	+
Terpenoids	+	+	++
Steroids	+	+	++
Alkaloids	-	+++	-
Anthraquinones	+	+	+
Cardiac Glycosides	-	-	-
Phenols	+	+	+

Anthocyanins	-	-	-
Phlobatanins	-	-	-
Tannins	+	+	+
Proteins	++	++	++

Where - = absent, + = slightly present, ++ = present, +++ = highly present

The result as shown in Table 1 revealed that *Solanum melongena* has carbohydrates, terpenoids, steroids, anthraquinones, phenols, tannins but quinones slightly present. Flavonoids and proteins were observed to be moderately present, while saponins, alkaloids, cardiac glycosides, anthocyanins and phlobatanins were absent. *Solanum macrocarpon* has carbohydrates, flavonoids, terpenoids, steroids, anthraquinones, phenols and tannins slightly present. Proteins and alkaloids were present and highly present respectively, however, saponins, cardiac glycosides, anthocyanins, phlobatanins, tannins and acids were absent. Carbohydrates, saponins, flavonoids, anthraquinones, phenols and tannins were observed to be present in *Solanum aethiopicum* samples. Terpenoids, steroids and proteins were moderately present and alkaloids, cardiac glycosides, anthocyanins, phlobatanins and tannins were absent.

Percentage Proximate Composition

Table 2: Percentage Proximate Composition of Three Varieties of Garden Egg

Varieties	Moisture	Total Ash	Crude Fibre	Crude fat	Protein	Carbohydrate
Solanum melongena	52.23±0.5[c]	23.70±0.14[a]	3.16±0.01[a]	6.03±0.03[b]	2.38±0.07	12.05±0.05[a]
Solanum aethiopicum	59.05±0.04[a]	17.49±0.15[c]	1.69±0.04[c]	8.05±0.01[a]	2.49±0.02	11.83±0.09[a]
Solanum macrocarpon	57.68±0.29[b]	22.71±0.05[b]	2.05±0.04[b]	5.04±0.04[c]	2.56±0.04	10.40±0.05[b]
LSD	*	*	*	*	N.S	*

Values are Mean ± S.D (Standard deviation) at $P \leq 0.05$, (*) = Significant; N.S = Not significant. Means with different alphabetical superscripts within a column are significantly different.

The result as shown in Table 2 revealed that there were significant differences in the moisture content of the three varieties at $p \leq 0.05$, with the highest mean value occurring in *Solanum aethiopicum* (59.05±0.04). *Solanum melongena* had the least moisture content at 52.23±0.51. The total ash content of the three varieties showed a significant difference with *Solanum melongena* having the highest mean value of 23.70±0.14, followed by *Solanum macrocarpon* (22.71±0.05), while the lowest mean value occurred in *Solanum aethiopicum* (17.49±0. 15). The crude fibre in the three varieties expressed significant differences within the samples, *Solanum melongena* had the highest mean value at (3.16±0.01), followed by *Solanum macrocarpon* (2.05±0.04), while *Solanum aethiopicum* had a mean value of (1.69±0.04) for the crude fibre content of the sample. Crude fat results in the three varieties revealed significant differences (Table 2). *Solanum aethiopicum* had the highest mean value of 8.05±0.01 while *Solanum macrocarpon* produced the lowest crude fat content with a mean value of 5.04±0.04. The result shows that no significant difference occurred in the total protein content for the three varieties observed. However, the highest mean value occurred in *Solanum macrocarpon* (2.56±0.04), followed by *Solanum aethiopicum* (2.49±0.02), while

Solanum melongena expressed the lowest mean value at (2.38±0.07) among the three varieties. The carbohydrate content in the three varieties of garden egg is as shown above (Table 2). The result shows that a significant difference occurred in the varieties of garden egg with *Solanum melongena* and *Solanum aethiopicum* being significantly different from *Solanum macrocarpon*. The highest mean value however occurred in *Solanum melongena* at (12.05±0.05), while *Solanum macrocarpon* had the lowest mean value of (10.40±0.05).

Elemental Analysis

Table 3: Trace Element Contents of the Three Varieties of Garden Egg with WHO Limits

Trace Element	*S. melongena*	*S. aethiopicum*	*S. macrocarpon*	WHO Limit ppm
Mg (ppm)	279.57±1.00^{a}	258.16±1.00^{b}	280.50±1.10^{a}	-
Ca (ppm)	106.80±1.00^{a}	76.29±0.89^{c}	84.95±1.19^{b}	-
Zn (ppm)	4.77±0.03^{b}	5.55±0.29^{a}	3.98±0.21^{c}	50.0
Cu (ppm)	0.88±0.01^{b}	1.18±0.11^{a}	0.29±0.07^{c}	0.50
Fe (ppm)	51.45±1.00^{a}	49.79±1.21^{a}	41.49±0.11^{b}	1.0
Mn (ppm)	5.53±0.11^{a}	5.43±0.10^{a}	3.44±0.24^{b}	5.0

Means with different alphabetical superscripts within the same row are statistically different.

The result of the trace elements in the three varieties of garden egg is as presented in Table 3. Significant differences occurred across all the varieties in each of the elements in consideration. The magnesium level in *S. macrocarpon* (280.50±1.10) was the highest, but not significantly different from that of S*. melongena* (279.57±1.00) and the two varieties are significantly different from *S. aethiopicon* with a mean value of 258.16±1.0. The calcium level of *S. melongena* was much higher than found in *S. aethiopicum* and *S. macrocarpum*. The level of significance in zinc and copper are similar, while that of iron and manganese are also similar. The highest mean value of zinc and copper occurred in *S. aethiopicum* with mean value 5.55±0.29 and 1.18±0.11 respectively, while *S. melongena* had the highest mean value of 51.45±1.00 and 5.53±0.11 in iron and manganese respectively. In comparison with WHO permissible limits, zinc was observed to be the WHO tolerable limits, while iron is above the limit. Manganese on the other hand is well fitted into the required body limit standard given by WHO.

Discussion

The medicinal benefits provided from the consumption of garden eggs are enormous. Garden egg has been reported for its ability to prevent constipation through its high fibre content. It is also reported for its cancer preventive activity (Afshari et al., 2016), its ability to lower high blood pressure, anti-cholesterol ability (Naeem and Ugur, 2019) and its antioxidant properties (Caguiat and Hautea, 2014). It also can inhibit neuro-inflammation and thereby facilitate the flow of blood to the brain. All these medicinal properties exhibited by this fruit are due to its high phytochemical, nutritional and mineral content (Islam et al., 2021).

The result obtained shows the presence of flavonoids and phenols which are known for having antioxidant activity. The presence of these two phytochemicals in the three varieties could be used in predicting the antioxidant capacity of garden egg as reported by Solanke and Tawar (2019). The varieties examined show the presence of carbohydrates but at a low concentration. Carbohydrate is a class of food molecule which when digested yields glucose to provide energy for body kinetic activities (Rollo et al., 2020). Garden eggs have been recommended for diabetic patients because of their low carbohydrate content, ability to lower blood pressure and its cholesterol reducing capacity (Ekpe et al., 2021). This result is in line with the published work of Agoreyo et al. (2012) who stated that *Solanum melongena* exhibited low carbohydrate content. The three varieties of garden egg exhibited the presence of tannins at a moderate amount, while *S. aethiopicum* alone showed the presence of saponins and only *S. macrocarpon* showed the presence of alkaloids and even at high amounts. These phytochemicals have been reported to have analgesic, anti-inflammatory, anti-hypertensive, and antimicrobial properties (Sofowora, 1993). Also, saponin and tannins have been reported to exhibit cytotoxic effects as well as cell growth inhibition (Asl and Hossein, 2008).

The result of the proximate analysis shows the moisture content of the different varieties with *Solanum aethiopicum* having the highest value. High moisture content reduces the stability of the fruit, and this could also be an indication of early fungi and bacteria attack (Alegbeleye et al., 2022), however, garden eggs are covered with a thin outer protective layer that minimizes bacterial and fungal penetration and improves the shelf-life of the garden egg (Agoreyo, 2012; Ossamulu et al., 2014). The result of the total ash content showed that the garden eggs have considerable ash content in them. This implies that the garden eggs have a high amount of inorganic matter in them, and this means that they contain a high number of mineral elements in them. This is evidenced by the result obtained in table 3. However, the values of the ash content in this result are above the earlier published results of (Auta et al., 2011; Agoreyo et al., 2012; Ossamulu et al., 2014). The low level of crude fibre in the three varieties is however higher compared to the work published by Agoreyo et al. (2012). This low fibre content, together with low carbohydrate and low fat could make these garden eggs a good diet for diabetes patients and for the patients of cardiovascular diseases (Showemimo and Olarewaju, 2004). The protein levels in these three varieties were also moderately low and comparable with those contained in the garden eggs examined by Agoreyo et al. (2012) that have the values of 5.79 and 4.58 for round shape and oval shape of *Solanum melongena* respectively.

Magnesium is an important element that plays vital roles in biochemical reactions. Magnesium is required for oxidative phosphorylation, energy production as well as in glycolytic reactions (Pasternak et al., 2010). It also plays key roles as cofactors in enzymatic reactions of protein synthesis, muscle, and nerve function, and in blood pressure regulation (Pasternak et al., 2010). The amount of magnesium in the varieties are lower than those reported by Agoreyo et al. (2012) who reported 2.26 and 2.56 mg/100g of the sample in the round and oval shapes of *S. melongena* variety respectively. Calcium is required for the formation of strong bone and teeth, while iron is a key component in the heme porphyrin ring of hemoglobin, the oxygen transported to the cells (Briguglio et al., 2020). Zinc is required in many enzyme functions, as it helps in immunity against bacteria and fungi and it is also important for body growth and development in children (Bhowmik et al., 2010). Copper is another important trace element as it is required for the process of normal erythrocyte function and regulation of the red blood cell. Excess amounts of copper in the body can lead to discomfort, diarrhea, blood traces in the urine and low blood pressure (Johnson, 2005). The amount of copper observed in the three varieties of garden egg in this work are relatively lower compared to those reported by Ossamulu (2014) which reported 0.8, 0.6, 0.9 and 5.2g/100g of the sample. The amount of iron and calcium in these three varieties are higher than those found in the four varieties of garden egg as reported by Agoreyo et al. (2012). This implies higher bioactivity prediction for these varieties as compared to *S. macrocarpon* (round and oval shapes), *S. aethiopicum* and *S. gilo* varieties reported Agoreyo et al. (2012). The obtained results for the manganese in the three varieties are slightly higher compared to those published by Ossamulu et al. (2014) but are still within the normal body range of 4.15/L. All the trace elements analyzed were present in the three varieties of the garden egg.

Conclusion

Garden eggs are important vegetables which nourish the body through its abundance of minerals, vitamins, and other essential nutrients. It is also rich in phytochemicals which perform numerous medicinal functions and protection against harmful substances. These phytochemicals present have exhibited some biochemical characteristics such as antioxidant, antifungal, antibacterial, blood pressure reduction etc. Nutritional contents, as well as the phytochemical constituents of different varieties of garden egg varies. However, the three varieties have abundant nutrients that will enrich the body with required nutrients. Any of the varieties can be recommended for consumption, especially, *S. melongena* (purple variety).

Recommendation

Based on the findings from this research work, it could be recommended that *Solanum* fruits should be frequently consumed, especially *Solanum melongena*, due to their high nutritional content as well as their possible medicinal properties owing to their various phytochemical constituents. As much as they should be consumed daily, it is advisable to consume them in moderation because of the high iron and magnesium content in them.

References

Wei, Q., Du, L., Wang, W., Hu, T., Hu, H., Wang, J., David, K. and Bao, C. (2019), "Comparative Transcriptome Analysis in Eggplant Reveals Selection Trend during Eggplant Domestication". *Int. J. Genomics,* (2):1-12. https://doi.org/10.1155/2019/7924383

Afshari, F., Serah, H., Hashemi, Z.S., Timajchi, M., Olamafar, E.,Ghotbi, L., Asadi, M., Elyasi, Z. and Ganjibakhsh, M. (2016). The Cytotoxic Effects of Eggplant Peel Extract on Human Gastric Adenocarcinoma Cells and Normal Cells. *Mod. Med. Lab. J.*, 1: 42-48

Agoreyo, B.O., Obansa, E.S. and Obanor, E.O. (2012). Comparative Nutritional and Phytochemical Analyses of Two Varieties of *Solanum melongena. Sci. World J.,* 7(1): 5-8.

Alegbeleye, O., Odeyemi, O.A., Strateva, M. and Stratev, D. (2022). Microbial Spoilage of Vegetables, Fruits and Cereals. *Appl. Food Res.*, 2(1): 1-10.https://doi.org/10.1016/j.afres.2022.100122.

Anosike, C.A., Obidoa, O. and Ezeanyika, L.U.S. (2012). The Anti-inflammatory Activity of Garden Egg (*Solanum aethiopicum*) on Egg Albumin-Induced Oedema and Granuloma Tissue Formation in Rats. *Asian Pac. J. Trop. Med.*, 62-66. https://doi.org/10.1016/S1995-7645(11)60247-2.

AOAC (1995). Association of Official Analytical Chemists. Official Methods of Analysis. 16th ed. Washington DC, USA. pp. 771.

AOAC (2000). Official Methods of Analysis of the Association of Official: Analytical Chemists 17th ed. Washington.

Asl, M.N. and Hossein, H. (2008). Review of Pharmacological Effects of *Glycyrrhiza spp*. and its Bioactive Compounds. *Phytother. Res.*, 22: 709-724. https://doi.org/10.1002/ptr.2362.

Auta, R., James, S.A., Auta, T. and Sofa, E.M. (2011). "Nutritive Value and Phytochemical Composition of Processed *Solanum incanum* (Bitter Garden Egg). "*Journal Sci. World,* 6(3): 5-6.

Bhowmik, D., Chiranjib, K.P. and Kumar. S. (2010). A Potential Medicinal Importance of Zinc in Human Health and Chronic Disease. *Int J. Pharm. Biomed. Sci.*, 1(1): 05-11.

Bonsu, K.O., Fontem, D.A., Nkansah, G.O., Iroume, R.N., Owusu, E.O. and Schippers, R.R. (2002). Diversity within the Gboma Eggplant (*Solanum macrocarpon*), an Indigenous Vegetable from West Africa, *Ghana J. Hort.,* 1: 50-58.

Briguglio, M., Hrelia. S., Malaguti, M., Lombardi, G., Riso, P., Porrini, M., Perazzo, P. and Banf, G. (2020). The Central Role of Iron in Human Nutrition: From Folk to Contemporary Medicine. *Nutrients*, 12(6): 1-17. https://doi.org/10.3390/nu12061761.

Caguiat, X.G.I. and Hautea, D.M. (2014). Genetic Diversity Analysis of Eggplant (*Solanum melongena* L.) and Related Wild Species in the Philippines using Morphological and SSR Markers. *Sabrao J. Breed Genet.*, 46(2): 183-201.

Chuku, E.C., Agbagwa, S.S., Chuku, O.S. and Worlu, C.W. (2020). Comparative Studies on the

Nutrient Compositions of Four Varieties of Egg Plants (*Solanum melongena*). *J. Agric., Env. Res. Managt,* 5(2): 530-540.

Clement, O.O., Asagba, S.O., Emus, O. and Oliseneku, O.O. (2018). Effects of Garden Egg, Carrot and Oat-Supplements on Biochemical Parameters in Cadmium Exposed Rats. *Afr. J. Biochem. Res.*, 12(3): 28-34. https://doi.org/10.5897/AJBR2016.0893.

Ekpe, I.P., Eze, K.A. and Dennis, A. (2021). Blood Glucose Lowering Effects of *Solanum melongena* (Garden Egg), *Solanum lycopersicum* (Tomatoes), *Daucus carota* subsp. *Sativus* (Carrot) Extracts on Lead Induced Toxicity in Albino Wistar Rats. *GCS Biol. Pharm. Sci.*, 14(1): 65-70. https://doi.org/10.30574/gscbps.2021.14.1.0007.

Islam, S.U., Ahmed, M.B., Ahsan, H. and Lee, Y.S. (2021). Recent Molecular Mechanisms and Beneficial Effects of Phytochemicals and Plant-Based Whole Foods in Reducing LDL-C and Preventing Cardiovascular Disease. *Antioxid.*, 10(784):1-28. https://doi.org/10.3390/antiox10050784.

Johnson, W.T. (2005). "In *Nutritional and Neuroscience*, "Lieberman, H.R., Kanarek, R.B., Prasad, C., Eds., Taylor and Francis, *Boca Raton*, FL, Chapter 17, 2005.

Khan, N., Ruqia, B., Hussain, J., Jamila, N., Rahman, N.U. and Hussain, S.T. (2013). Nutritional Assessment and Proximate Analysis of Selected Vegetables from Parachinar Kurram Agency. *Am. J. Res. Commun*., 1(8): 184-198. www.usa-journals.com.

Khare, T., Anand, U., Dey, A., Assaraf, Y.G., Chen, Z.S., Liu, Z. and Kumar, V. (2021). Exploring Phytochemicals for Combating Antibiotic Resistance in Microbial Pathogens. *Front. Pharmacol*. 12:720726 pp 1-18. https://doi.org/10.3389/fphar.2021.720726.

Lekadou, T.T., Coffi, P.M.J., Yao, S.D.M. and Ama, T.J. (2019), "Vegetative Growth Response of Garden Egg (*Solanum aethiopicum* L.) to Combined Effects of Fertilizer Types and Irrigation Regimes Applied on Littoral Tertiary Soil in Cote d'lvoire ". *Int. J. plant soil sci.,* 30(5): 1-11. https://doi.org/10.9734/IJPSS/2019/v30i530190

Ma, Z., Du, B. Li, J. Yang, Y. and Zhu, F. (2021). An Insight into Anti-inflammatory Activities and Inflammation Related Diseases of Anthocyanins: A Review of Both *In Vivo* and *In Vitro* Investigations. *Int. J. Mol. Sci.*, 22(11076): 1-17. https://doi.org/10.3390/ijms222011076

Mandal, S. (2010). Induction of Phenolic, Lignin and Key Defense Enzymes in Garden Egg (*Solanum melongena* L.) Roots in Response to Elicitors. *Afr. J. Biotechnol.,* 9(47): 8038-8047. https://doi.org/10.5897/AJB10.984

Naeem, M.Y. and Ugur, S. (2019). Nutritional Content and Health Benefits of Eggplant. *Turkish Journal of Agriculture - Food Sci. Technol.*, 7(3): 31-36. DOI: https://doi.org/10.24925/turjaf.v7isp3.31-36.3146

Odoh, R., Gary, Y.G., Sandra, U.I. and Archibong, C.S. (2018). Nutritional Evaluation and Proximate Analysis of Some Edible Leafy Vegetables in Northern Nigeria. *J. Biosci. Biotechnol. Discov*., 2: 30-45. https://doi.org/10.31248/JBBD2017.044

Ossamulu, I.F., Akanya, H.O., Jigam, A.A. and Egwim, E.C. (2014). Evaluation of Nutrient and Phytochemical Constituents of Four Eggplant Cultivars. *Food Sci.,* 73: 26424- 26428.

Rollo, I., Gonzalez, J.T., Fuchs, C.J., van Loon, L.J.C. and Williams, C. (2020). Primary, Secondary, and Tertiary Effects of Carboydrate Ingestion During Exercise. *Sports Medicine*, 50(11): 1863-1871. https://doi.org/10.1007/s40279-020-01343-3.

Showemimo, F.A., and Olarewaju, J.D., (2004). "Agro-Nutritional Determinants of Some Garden Egg Varieties (*Solanum gilo* L.),". *J. Food Technol.,* 2(3): 172-175. https://medwelljournals.com/abstract/?doi=jftech.2004.172.175.

Sofowora, A. (1993). *Medicinal plants and Traditional medicine in Africa* (Ibadan, Nigeria: Spectrum Books Ltd).

Solanke, S.B., and Tawar, M.G., (2019). Phytochemical Information and Pharmacological

Activities of Garden egg (*Solanum melongena* L.): A Comprehensive Review. *EAS J. Pharm. Pharmacol.,* 1(5): 103-114. https://doi.org/10.36349/EASJPP.2019.v01i05.001.

Syfert, M.M., Castaneda-Alvauz, N.P., Khoury, C.K., Sarkinen, T., Sosa, C.C. and Achicnoy, H.A. (2016). Crop Wild Relatives of the Brinjal Eggplant (*Solanum melongena*): Poorly Represented in Gene Banks and many Species at Risk of Extinction. *Am. J. Bot*., 103: 635-651. https://doi.org/10.3732/ajb.1500539.

Tabassum, N.E., Das, R., Lami, M.S., Chakraborty, A.J., Mitra, S., Tallei, T.E., Idroes, R., Mohamed, A.A., Hossain, M.J., Dhama, K., Mostafa-Hedeab, G. and Emran, T.B. (2022). *Ginkgo biloba*: A Treasure of Functional Phytochemicals with Multi-medicinal Applications. *Evid.-Based Complement. Altern. Med.*, 1-30. https://doi.org/10.1155/2022/8288818.

Usman, M., Khan, W.R., Yousaf, N., Akram, S., Murtaza, G., Kudus, K.A., Ditta, A., Rosli, Z., Rajpar, M.N. and Nazre. M. (2022). Exploring the Phytochemicals and Anti-Cancer Potential of the Members of *Fabaceae* Family: A Comprehensive Review**.** *Molecules*, 27(12):1-21. https://doi.org/10.3390/molecules27123863.

Trease, G.E. and Evans, W.C. (1985). Pharmacognosy. 11th Edition, Tindall Ltd, London. Pp 60- 75.

Wada, O. (2004). What are Trace Elements? Their Deficiencies and Excess States. *Jpn. Med. Assn. j*., 47(8):351-358.