Original Research Article

In vitro Antioxidant and Antimicrobial Activity of Ethanolic Extract of Egg Plant (*Solanum melongena Linn*) Fruit

ABSTRACT

Ethno-medicinal use of plant has been effective in the amelioration of oxidative stress and in the inhibition of pathogenic microorganism. The ethanolic extract of *Solanum melongena* Linn fruit as a potent *in vitro* antioxidant and antimicrobial agent was investigated using standard protocols. The results showed that the ethanolic extract of *Solanum melongena* Linn fruit scavenged 1,1-diphenyl-2-picrylhydrazyl (DPPH) and nitric oxide ($NO^{\cdot}$), and inhibited lipid peroxidation (LPO) compared to standard (vitamin C). It also reduced ferric ion (as measured through ferric reducing antioxidant potential (FRAP)) compared to the standard, ethylenediaminetetraacetic acid (EDTA). The observed *in* vitro antioxidant activity of the sample was dose dependent. At a minimum inhibition concentration (MIC) of 50 µg/ml, the ethanolic extract of *Solanum melongena* Linn fruit showed the highest activity against the bacterium, *Staphylococcus auerus* (16.33 ± 2.69mm) and the fungi, *Aspergillus flavus* (3.33 ± 0.38mm at 70.00 µg/ml). The bacteria, *Eschericha coli and Salmonella typhi* and the fungus, *Rhizopus stolonifer* were not susceptible to the ethanolic extract at the tested concentrations. The ethanolic extract at 10.00 µg/ml and 30.00 µg/ml could not inhibit any of the studied pathogens. In conclusion, the ethanolic extract of *Solanum melongena* Linn fruit exhibited a varied degree of appreciable *in vitro* antioxidant activities compared with the tested methods and standard. Its activity against the tested bacterial and fungal strains underscores its apparent pharmacological potential, warranting further studies.

Keywords: *Ethnomedicinal, Solanum melongena Linn fruit, antioxidant, susceptibility and pathogens*.

INTRODUCTION

The use of plant for their ethnomedicinal potentials has long been applicable in the search to overcome drug resistance conditions [1]. And, plant phytochemicals, including phenol, flavonoids, saponins and tannins, ensure the protection of plants against pathogenic microorganism [2]. Antioxidant studies are of great importance in plants studies. This is because; they are useful in the verification of the antioxidant potentials of phytoconstituents [3]. Antioxidants boost biological defense system against free radical attack. Free radicals are unpaired electrons that are very reactive [2] and are constantly generated in the living system resulting to diseased conditions when left unchecked by the defense system. Antioxidants neutralize the free radical effects, thus rendering them inactive [4], hence antioxidant may be useful in combating diseased states. There is an increasing need to screen and exploit plants and plant parts for the possible antioxidant potentials. Moreover, plant antioxidants show relatively minimal adverse effect.

Solanum melongena is one of the best known egg plant species. The name egg plant was derived from the egg like shape. It is the third most important crop in the family of the solanaceas after potato and tomato [5], belonging to the genus solanum with lots of species. These species including *Solanum incanum, Solanum nigrum* and *Solanum melongena* are all cultivated in Africa: as an animal plant. *Solanum melongena* bears different colours, shapes, sizes and fruits [6]. The fruit is pendent, fleshly berry and the colour ranges from shinning purple to white, green, yellow and black often with strips and patches on the skin. This fruit shape varies from long cylindrical to round, oblong and oval shape and it undergoes self-pollination [7]. Egg plant has found indigenous medicinal uses including the management of diabetic and hyperlipidemia [2, 8], could reduce body weight, possess nutraceutical properties like analgesic and antipyretic potentials [9], antioxidant, which is evident as the egg plant fruit browns upon exposure to air [2, 10], antimicrobial [11]. These warranted the study aimed at assessing the *in vitro* antioxidant and antimicrobial activity of the ethanolic extract of *Solanum melongena* Linn fruit.

MATERIALS AND METHODS

Plant materials and preparations

Matured egg plant fruits were bought from a local market, *Ehere* market, in Aba, Abia State during the fruiting season of May, 2016. The fruit was identified as *Solanum melongena* Linn in the Plant Science Department, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The fruits were washed with clean tap water, crushed into smaller pieces using a knife and were air-dried for two weeks. The air-dried fruits were milled into powder using a laboratory miller and stored in an air tight container.

Extraction and concentration

200g of the Egg plant fruit, powder were taken in separate containers. To this, 1000 ml of ethanol was added and kept for 72 hours with interval shaking. The extract was filtered with No 1 Whatman filter paper. The filtrate was concentrated using water bath at 60^{o}C and was further dried in an oven set at 50 ^{o}C. The extract was placed into a sample bottle and stored in a refrigerator at about 4^{o}C until it was required for experiment.

Test Organisms

The bacterial and fungal strains were obtained from New Era Specialist Hospital, Laboratory section and from Hyon Foods Limited Microbiological Laboratory, both in Aba Abia State, Nigeria. In particular, *Pseudomonas aeroginosa, Candida albican and Staphylococcus aerues* were obtained from New era specialist while the other tested strains viz: *Eschericha coli*, *Shigella dystenteriae, Salmonella typhi, Rhizopus stolonifer* and *Aspergillus flavus* were obtained from Hyon Foods Laboratory. The bacteria biochemical characterization was done at Hyon foods Limited.

Media preparation and sterilization

Nutrient agar (NA) and Potato dextrose Agar (PDA) were used for bacteria and fungi inoculation respectively. They were prepared in accordance with the direction for use and autoclaved at 121^{o}C for 20 minutes and then separately poured into the Petri dishes with different bacteria and fungi species.

Antimicrobial activity of the ethanolic extract of *Solanum melongena* Linn fruit

The disc diffusion method was used Nostro *et al.,* [12]. Stock solution (600 mg/ml) of extract was prepared using the diluent. Discs (6 mm) in diameter was made from Whatmann No.1 grade filter paper with the aid of a mechanical perforator and sterilized by autoclaving at 121^{o}c and were impregnated with 10µl of different concentrations (10 µg/ml, 30 µg/ml, 50 µg/ml and 70 µg/ml) of the extract were inoculated and investigated. Each of the discs was placed at the center of the petri dish either for bacteria strains on NA or fungi strains on PDA. The plates were incubated at 37 ºC for 20 – 24 hours for bacterial studies and 25^{o}c for 48 - 72 hours for fungal studies. Ciprofloxacin (25 µg/disc) and Fluconazole (10 µg/disc) were used as control. All tests were performed in triplicate and the antibacterial and antifungal activities were expressed as the mean diameter of inhibition zones (mm) produced by the ethanolic extract of *Solanum melongena* Linn fruit.

3.12 Antioxidant capacity of the ethanolic extract of *Solanum melongena* Linn fruit

Determination of 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity

The DPPH radical scavenging activity was carried by the method described by Mensor *et al.* [13]. This method is based on the principle that when DPPH reacts with an antioxidant compound, which can donate hydrogen, itself is reduced. The free radical scavenging activity of the ethanolic extract of Solanum melongena Linn fruit was determined *in vitro* by DPPH assay. DPPH (5 mg) was weighed accurately using a pre-calibrated weighing balance and transferred to a 5 mL volumetric flask, dissolved (by sonication) and diluted with methanol to achieve 1 mg mL-1 strength (stock I). The stock I was diluted with methanol to obtain 0.3 mM DPPH solution. DPPH in methanol (0.3 mM) was prepared and 3.0 ml of this solution was added to 100 µl of ethanolic extract solution in water at different

concentrations (200.0 µg/ml, 100.0 µg/ml, 50.0 µg/ml, 25.0 µg/ml, 12.5 µg/ml) and to vitamin C at 100.0 µg/ml as the standard. The mixture was incubated at room temperature for 30 minutes and the absorbance was measured at 517 nm. Percentage inhibition of DPPH free radical was calculated based on the control reading using the following equation:

$$\% \text{ inhibition of DPPH radical} = \frac{\text{Absorbance of control - Absorbance of test}}{\text{Absorbance of control}} \times 100$$

Determination of ferric reducing antioxidant power (FRAP)

The ferric reducing antioxidant power was carried out as described by Benzie and Strain [14]**.** This method is based on the principle that ferric iron (Fe^{3+}) is initially reduced by electron-donating antioxidants present within the sample to its ferrous form (Fe^{2+}). The working solution was freshly prepared by mixing Acetate buffer (300 mM) pH 3.6 (3.1 g sodium acetate. $3H_2O$ and 16 ml glacial acetic acid in 1000 ml buffer solution**),** 2, 4, 6-triphridyl-s-triazine (TPTZ) 10 mM in 40 mM HCl and $FeCl_3.6H_2O$ (20 mM) in distilled water in the ratio of 10:1:1. This FRAP reagent (working solution) (3ml) and sample solution at concentrations of 12.5 µg/ml, 25.0 µg/ml, 50.0 µg/ml, 100.0 µg/ml and 200.0 µg/ml and ethylnediaminetetraacetic acid (EDTA) at 100.0 µg/ml as a standard were mixed and allowed to stand for 4 minutes. The absorbance was taken at 593 nm. The standard was tested in a parallel process. Calculations were made using a calibration curve. The ferric reducing antioxidant power of the sample was calculated using the formula below:

$$\frac{\text{Absorbance of control - Absorbance of test}}{\text{Absorbance of control}} \times 100$$

Determination of lipid peroxidation inhibition assay

A modified thiobarbituric acid-reactive species (TBARS) assay [15] was used to measure the lipid peroxide formed, using egg yolk homogenates as lipid rich media [16]. This method is based on the principle that malondialdehyde (MDA) in the sample reacts with thiobarbituric acid (TBA) to generate a MDA-TBA adduct. Three (3) ml of liver homogenate was added to 100 µl of 15 mM ferric chloride and was shaken for 30 minutes. From collected mixture, 100 µl was added with 1ml of different concentrations (200.0 µg/ml, 100.0 µg/ml, 50.0 µg/ml, 25.0 µg/ml and 12.5 µg/ml of Ethanolic extract of *Solanum melongena* Linn fruit) individually in different test tubes and to vitamin C which was used as a standard (100.0 µg/ml). All the test tubes were incubated for four (4) hours at 37°C. After incubation, 1.1 ml of 30% trichloroacetic acid (TCA) and 1.1 ml of 0.65% thiobarbituric acid (TBA) were added to all tubes containing the mixture. After 30 minutes of incubation in a shaking water bath and subsequent cooling in ice-cold water for 10 minutes, the tubes were centrifuged at 800 g for 15 minutes. The absorbance was measured at 530 nm. The percentage inhibition of lipid peroxidation was calculated by using the equation below:

$$\% \text{ inhibition} = \frac{\text{Absorbance of control - Absorbance of test}}{\text{Absorbance of control}} \times 100$$

Determination of nitric oxide radical (NO.) radical scavenging assay

Nitric oxide radical scavenging assay was determined using Griess reaction with minor changes as described by Marcocci *et al.* [17]. This method is based on the principle that sodium nitroprusside in aqueous solution at physiological pH spontaneously generates nitric oxide, which interacts with oxygen to produce nitrite ions, which were then determined by the use of Griess IIIosvoy reaction. Two (2) ml of 10mM sodium nitroprusside dissolved in 0.5ml phosphate buffer saline (pH 7.4) was mixed with 0.5ml of different concentration (200.0 µg/ml, 100.0 µg/ml, 50.0 µg/ml, 25.0 µg/ml, 12.5 µg/ml) of ethanolic extract of Solanum melongena Linn fruit and 100.0 µg/ml of vitamin C as the standard. The mixture was then incubated at 25°C. After 150min of incubation, 0.5mL of the incubated solution is withdrawn and mixed with 0.5mL of Griess reagent [(1.0mL sulfanilic acid reagent (0.33% in 20% glacial acetic acid at room temperature for 5min with 1ml of naphtylenediaemine dichloride) 0.1%w/v)]. The

mixture is then incubated at room temperature for 30mins and its absorbance pouring into a cuvette is measured at 546nm. The amount of nitric oxide radical is calculated as:

$$\% \text{ inhibition of NO radical} = \frac{\text{Absorbance of control - Absorbance of test}}{\text{Absorbance of control}} \times 100$$

Statistical Analysis

Collected data were subjected to statistical analysis using statistical package for the social sciences (SPSS) for Windows version 22.0. Results were expressed as Mean ± standard error of the mean (SEM).

RESULTS AND DISCUSSION

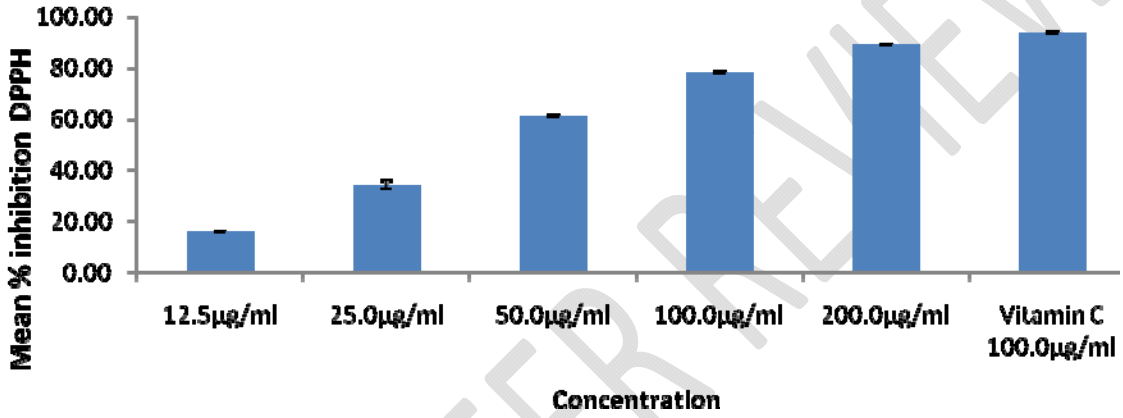

Figure 1: DPPH radical scavenging activity of the ethanol extract of *Solanum melongena* Linn fruit at different concentration compared to vitamin c at 100.0µg/ml.

Figure 1 above showed a progressive increase in the DPPH radical scavenging ability of ethanol extract of *Solanum melongena* Linn fruit at different concentrations compared to vitamin C (a standard) at 100.0 µg/ml. The highest scavenging ability for the ethanol extract was observed at 200.0 µg/ml (89.11%) compared to vitamin c at 100.0 µg/ml (93.70%). The figure further showed concentration dependent scavenging ability of the plant extract. The plotted values are means ± SEM of triplicate determination.

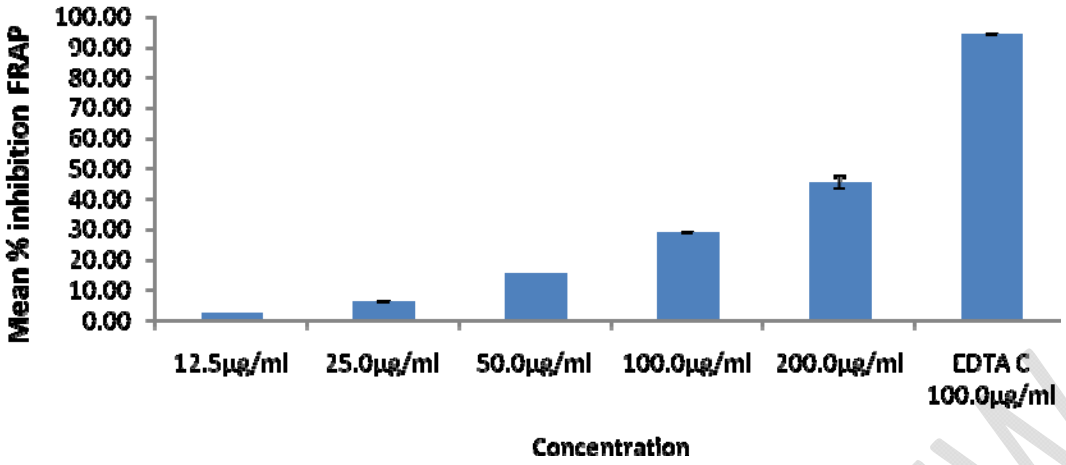

Figure 2: Ferric reducing antioxidant power of ethanol extract of *Solanum melongena* Linn fruit at different concentration compared to EDTA at 100.0 µg/ml.

Figure 2 above showed the iron binding capacities in terms of percent inhibition of the ethanol extract of *Solanum melongena* Linn fruit at different concentration (12.5µg/ml through 200.0µg/ml). The extract scavenging ability is not comparable at 200.0 µg/ml (45.33%) compared to EDTA (a standard) at 100 µg/ml (93.95%). The plotted values are means ± SEM of triplicate determination.

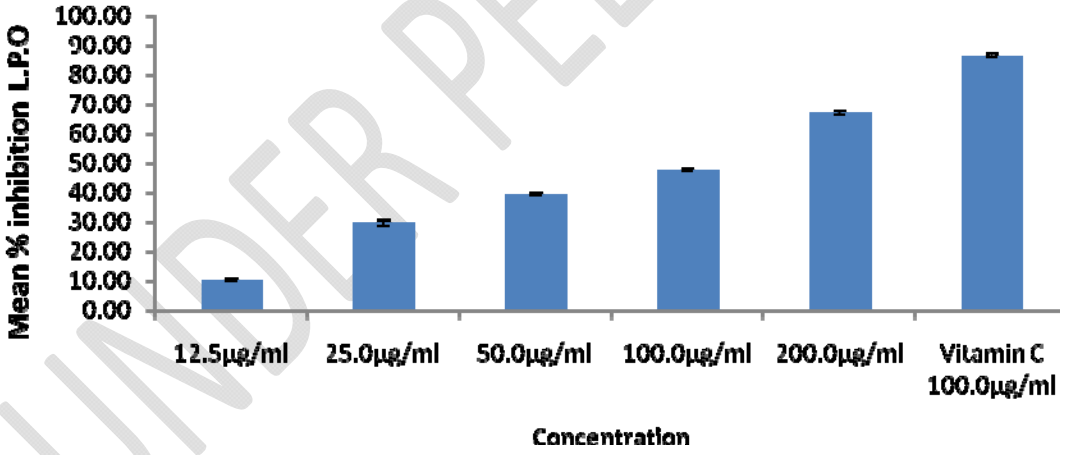

Figure 3: Lipid peroxidation inhibition activity of the ethanol extract of *Solanum melongena* Linn fruit at different concentration compared to vitamin C at 100.0 µg/ml.

Figure 3 above showed the inhibition effect of ethanolic extract of *Solanum melongena* Linn fruit and vitamin c (a standard) on lipid peroxidation inhibition ability. The inhibitory effect is concentration dependent. The plotted values are means ± SEM of triplicate determination.

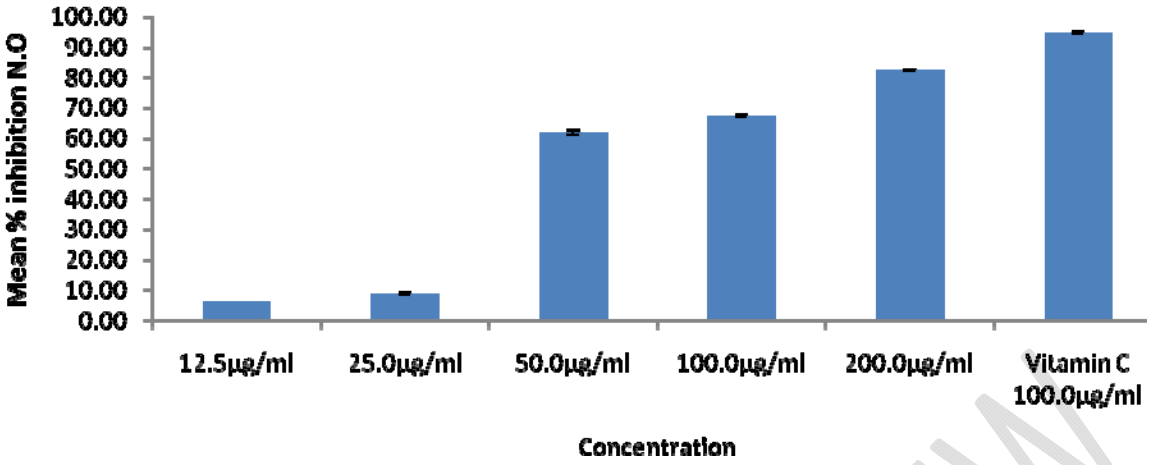

Figure 4: Nitric oxide radical scavenging activity of the ethanolic extract of *Solanum melongena* Linn fruit at different concentration compared to vitamin C at 100.0µg/ml.

Figure 4 above showed the percentage inhibition of nitric oxide generated by ethanol extract of *Solanum melongena* Linn fruit and vitamin c (a standard). The extract scavenging ability is concentration dependent. The concentration at 200.0 µg/ml (82.08%) is comparable to 100.0µg/ml (94.53%) for vitamin c (a standard). The plotted values are means ± SEM of triplicate determination.

Table 1: Biochemical characterization of test organisms

Parameter	***Salmonella spp.***	***E. coli***	***S. auerus***	***P. aeroginosa***	***S. dysentenae***
Grams	Gram (-ve)	Gram (-ve)	Gram (+ve)	Gram (-ve)	Gram (-ve)
Motility	(+ ve)	(+ve)	(-ve)	(+ve)	(-ve)
Catalase	(+ ve)	(+ ve)	(+ ve)	(+ ve)	(- ve)
Coagulase	(- ve)	(- ve)	(+ ve)	(- ve)	N/A
Indole	(- ve)	(+ ve)	(+ ve)	(+ ve)	(- ve)
Urease	(- ve)	(- ve)	(- ve)	N/A	(- ve)
Citrate	(- ve)	(- ve)	(- ve)	(+ve)	(- ve)
Methyl red	(+ ve)	(- ve)	(+ ve)	(- ve)	(+ ve)
Voges proskauer	(- ve)	(- ve)	(- ve)	(- ve)	(-ve)
Glucose	(+ ve)	(+ ve)	(+ ve)	(- ve)	(+ ve)
Lactose	(- ve)	(+ ve)	(+ ve)	(- ve)	(- ve)
Maltose	(+ ve)	(+ ve)	(+ ve)	(- ve)	N/A
Mannitol	(+ ve)	(+ ve)	(+ ve)	(+ ve)	N/A
Oxidase	(- ve)	(- ve)	(- ve)	(+ ve)	(- ve)

Note: -ve , +ve and N/A signifies negative, positive and not analyzed respectively.

Table 2: Antimicrobial susceptibility test results for ethanol extract of *Solanum melongena* Linn fruit on some selected microorganisms.

Pathogens	**Extract conc.** (µg/ml)	**Negative control**	**Zone of inhibition of extract (mm)**	**MIC** of extract (µg/ml)	**Standard drugs** Ciprofloxacin **Zone of inhibition (mm)**
Eschericha coli	10.00	0.00 ± 0.00	-	-	21.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	-		
	70.00	0.00 ± 0.00	-		
Staphylococcus auerus	10.00	0.00 ± 0.00	-	50.00	22.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	15.33 ± 1.83		
	70.00	0.00 ± 0.00	16.33 ± 2.69		
Pseudomonas aeroginesa	10.00	0.00 ± 0.00	-	70.00	18.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	-		
	70.00	0.00 ± 0.00	13.67 ± 0.38		
Shigella dysenteriae	10.00	0.00 ± 0.00	-	70.00	22.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	-		
	70.00	0.00 ± 0.00	12.83 ± 1.25		
Salmonella typhi	10.00	0.00 ± 0.00	-	-	24.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	-		
	70.00	0.00 ± 0.00	-		
For some fungi					Fluconazole
Candida albican	10.00	0.00 ± 0.00	-	50.00	20.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	1 ± 0.00		
	70.00	0.00 ± 0.00	2 ± 0.00		
Rhizopus stolonifer	10.00	0.00 ± 0.00	-	-	-
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	-		
	70.00	0.00 ± 0.00	-		
Aspergillus flavus	10.00	0.00 ± 0.00	-	50.00	24.00
	30.00	0.00 ± 0.00	-		
	50.00	0.00 ± 0.00	0.67 ± 0.38		
	70.00	0.00 ± 0.00	3.33 ± 0.38		

Table 2 above showed the inhibitory effect of ethanol extract of *Solanum melongena* Linn fruit with minimum inhibition concentrations (MIC), the standard antibacterial drug (Ciprofloxacin) and antifungal standard drug (Fluconazole) against some selected microorganisms. *Staphylococcus auerus* recorded the highest MIC at 50.00 µg/ml showing 15.33mm inhibition zone, *Pseudomonas aeroginesa* and *Shigella dystenteriae* had MIC of 70.00 µg/ml with 13.67 mm and 12.83 mm for their respective inhibition zones compared to the standard drug

(Ciprofloxacin). However, *Salmonella typhi* and *Eschericha coli* were not inhibited at the tested concentration. Furthermore, *Candida albican* and *Aspergillus flavus* both showed a MIC of 50.00µg/ml and inhibition zone of 1.00 mm and 0.67 mm respectively against fluconazole, which showed inhibition zones of 20.00 mm and 24.00mm respectively. *Rhizopus stolonifer* was not inhibited by the ethanolic extract of *Solanum melongena* Linn fruit.

Discussion

There is no over stating the importance of antioxidants and antimicrobial agents in the search for alternative medicine. Most plants possess these potentials of providing pharmaceutical active substances via secondary metabolites which can be evaluated. DPPH is a stable free radical widely used to evaluate scavenging ability of different antioxidants. The result of this study showed that as the concentration increases, the scavenging activity increases. This reveals that *S. melongena* could be a potent *in-vitro* antioxidant. Gradiappan and Rangasamy, [18], reported a similar finding on antioxidant activity of different species of solanaceae. This suggests that *Solanum melongena* Linn fruit is capable of donating hydrogen to a free radical in order to remove odd electrons that lead to free radical reactivity. This is the main mechanism of determining DPPH radical scavenging activity as noticed by the change of colour that was measured spectrophotometrically. This could imply that pathological health challenges could be managed with ethanolic extract of *Solanum melongena* Linn fruit at high concentration [19]. The highest scavenging ability for the ethanolic extract was observed at 200.0 µg/ml (89.11%) compared to vitamin c at 100.0 µg/ml (93.70%).

Generally, plant acts as antioxidant via metal chelating, as a reducing agent and/or free radical scavenger [3]. Ethanolic extract of *Solanum melongena* Linn fruit FRAP assay was done to determine its ability to reduce Fe^{3+}. FRAP study uses these three mechanisms at the same time to achieve antioxidant potentials. Free radicals chains are broken by donating hydrogen, which is a reducing activity. The ethanolic extract of *Solanum melongena* Linn fruit could donate electrons to stabilize radical activity. This makes it a good scavenger. This plant extracts reduced ferric iron as an antioxidant when compared to a standard EDTA though its inhibitory effect was minimal. Furthermore, the reducing activity increased as the concentration increases. This points that the extracts could play pivotal roles to protect against oxidative damage [2].

In this study, the lipid peroxidation inhibition activity was determined using the TBARS assay. TBA reacts specifically with MDA, a secondary product of lipid peroxidation to give a red chromogen, which may then be determined spectrophotometrically [15]. The present study also showed concentration dependent for the antioxidant activity. This study further revealed that the ethanolic extract of *Solanum melongena* Linn fruit could stand against reactive radical species from producing adducts from lipids, proteins, and DNA. This suggests that oxidation of unsaturated fatty acid in biological membranes could be ameliorated through ingestion of ethanolic extract of *Solanum melongena* Linn fruit at high concentration. Nitric oxide ($NO^{\cdot}$), a synthetic product of L-arginine, could play physiological roles in the endothelial relaxation of the smooth muscles [20]. However, in the cells, when the antioxidant level is low, there is a concomitant production of peroxynitrite (ONOO.). This is the chief free radical produced from nitric oxide. Free radicals have been implicated in the etiology of inflammations and aging related disease conditions. Hence, there is a need for the system to constantly maintain its antioxidant defenses. Ethanolic extract of *Solanum melongena* Linn fruit inhibited $NO^{\cdot}$ oxidation in this *in vitro* study. NO scavenging activity showed a similar pattern of increasing activity with increasing concentration [21; 22].

The ethanolic extract of *S. melongena* Linn fruit exhibited varying degree of antibacterial and antifungal activities on most of the tested pathogens (*Eschericha coli*, *Staphalococcus auerus*, *Pseudomonas aeroginosa*, *Shigella dysenteriae*, *Salmonella typhi*, *Candida albican*, *Rhizopus stolonifer* and *Aspergillus flavus*) as shown in the results (Table 2). The ethanolic extract of *Solanum melongena* Linn fruit showed the most inhibitory effect against *Staphalococcus auerus*, with inhibition zone of 15.33 mm at 50.00 µg/ml and a MIC of 50.00 µg/ml compared to *Shigella dysenteriae* (12.83mm at 70µg/ml) and *Pseudomonas aeroginosa* (13.67mm at 70.00 µg/ml). This is an indication that as the concentration of the extract increases the inhibition of these microbes would increase. The extract exhibited antibacterial activity against the tested bacterial compared to a used standard drug (Ciprofloxacin at 25µg/disk).This could indicate its broad spectrum activities as an antimicrobial agent and with a potent

pharmacological activity. These results are comparable with the report by Oranusi *et.al.* [23], on antimicrobial activity of *Chrysophyllum cainito* and Ajiboye *et.al*. [24], for antimicrobial activity of fruit pulp on *Dialium guineese.* Further to this, the antifungal activities of the extract appear to be more potent on the fungus (*Asperigulls flavus*) with 0.70mm and 3.33mm for 50µg/ml and 70mg/ml respectively and a MIC of 50µg/ml than the other tested fungi compared to standard antibiotics (Fluconazole at 10µg/disk). The extract did not inhibit the activity of the fungi *Rhizopus stolonifer*. The spectra of antimicrobial activity shown by the extract could be as a result of the presence of flavonoid, tannins and saponin.

CONCLUSION

The ethanolic extract of *Solanum melongena* Linn fruit exhibited a varied degree of appreciable *in vitro* antioxidant activities compared with the tested methods and standard. Its activity against the tested bacterial and fungal strains underscores its apparent pharmacological potential, warranting further studies.

REFERENCES

[1] Egbuonu ACC. Comparative investigation of the antimicrobial and antifungal potentials of the extracts of watermelon (Citrullus lanatus) rind and seed. European J. medicinal plant. 2015; 9(4): 1 – 7.

[2] Mbah UO, Egbuonu ACC. Ethanolic Extract of Solanum melongena Linn Fruit Mitigated Monosodium Glutamate-Induced Oxidative Stress. Intl. J. Biochem. Res. & Rev. 2017; **18**(2): 1-8.

[3] Kasote DM, Katyare SS, Hegde MV, Bae H.. Significance of antioxidant potential of plants and its relevance to therapeutic applications. Intl. J. Biol. Sci. 2015; **11:** 982–991.

[4] Obeagu EI. A Review on Free Radicals and Antioxidants. Int. J. Curr. Res. Med. Sci.. 2018; 4(2): 123-133.

[5] FAOSTAT. Agriculture data. http://faostat.fao.org. 2007; Accessed April 6th, 2016.

[6] Chowdhury MJ, Ahmad S, Nazim UM, Quamruzzaman AKM, Patwary MA. Expression of heterosis for productive traits in F1 brinjal (Solanum melongena L.) hybrids. The Agriculturists. 2010; **8** (2): 8-13.

[7] Houshna BN. Morphological diversity in eggplant (*Solanum melongena* L.), their related species and wild types conserved at the National gene bank in Mauritius.2009; Master's thesis No. 57.

[8] Kwon YI, Apostolidis E, Shetty K. In vitro studies of eggplant (Solanum melongena) phenolics as inhibitors of key enzymes relevant for type 2 diabetes and hypertension. Bioresource Technol. 2007; **99**(8): 2981- 2988.

[9] Srivastava A, Yadar S. Analgesic activity of root extract of *Solanum melongena* Linn fruit. Intl. J. Res. in Ayurveda & Pharmacy. 2011*;* **2**(5):1615 - 1617.

[10] Mbah UO, Egbuonu ACC. Ameliorative Potentials of Egg Plant (*Solanum melongena* Linn) Fruit Ethanolic Extract on Monosodium Glutamate- Intoxicated Rats' Lipid Profile, Haematology and Heart Histology. Intl. J. Biochem. Res. & Rev.. 2017; **18**(2): 1-10.

[11] Amutha S. Screening of antibacterial activity of *Solanum melongena* seed extracts on selected human pathogenic bacteria. Intl. J. Pharma & Biosci..2014; **5**(4):208 - 213.

[12] Nostro A, Germano MP, D'Angelo V, Marino A, Cannatelli MA. Extraction methods and bioautography for evaluation of medicinal plant antimicrobial activity. Letters *in* Appl. Microbiol. 2000*;* **30**: 379-384.

[13] Mensor LL, Fabio SM, Gildor GL, Alexander SR, Tereza CD, Cintia SC, et al. Screening of Brazilian plant extracts for antioxidant activity by the use of DPPH free radical methods. Phytotherapy Research. 2001; **15**:127-130.

[14] Benzie IFF, Strain JJ. Ferric reducing/antioxidant power assay: Direct measure of total antioxidant activity of biological fluids and modified version for simultaneous measurement of total antioxidant power andascorbic acid concentration. Methods in Enzymology.1999; **299**:15-27.

[15] Awah FM, Uzoegwu PN, Oyugi JO, Rutherford J, Ifeonu P, Yao X, et al. Free radical scavenging activity and immunomodulatory effect of Stachytarpheta angustifolia leaf extract. Food Chemistry.2010; **119**: 1409–1416.

[16] Ruberto G, Baratta MT, Deans SG, Dorman HJD. Antioxidant and antimicrobial activity of Foeniculum vulgare and Crithmum maritimum essential oils. Planta Medica. 2000; **66**: 687–693.

[17] Marcocci L, Maguire JJ, Droyl-lefaix MT, Packer L. The nitric oxide scavenging properties of Ginkgo biloba extract. Biochemical & Biophysical *Res.* Comm. 1994; **201**:748-755.

[18] Gandhiappan J, Rangasamy R. Comparative study on antioxidant activity of different species of Solanaceae family. Adv. Appl. Sci. Res. 2012; **3** (3):1538-1544.

[19] Ghosal M, Mandal P. Phytochemical screening and antioxidant activities of two selected 'BIHI' Fruits used as vegetables in Darjeeling Himalaya. Intl. J. Pharmacy & Pharma. *Sci*.. 2012; **4**: 567-574.

[20] Mbah UO, Egbuonu ACC. Alcohol-induced Teratogenesis: Biochemical Basis, Management Strategies and Possible Ameliorative Roles of L-arginine. Annals Agric. & Environ. Sci. 2016; 0**1**(01):1–6.

[21] Rana SVS, Janu A, Singh R. Inevitable glutathione, then and now. Indian J. Exptal. Bio. 2002; **40**: 706 - 716.

[22] Gacche RN, Kabaliye, VN, Dhole NA, Jadhav D. Antioxidant potential of selected vegetables commonly used in diet in Asian subcontinent. Indian J. Nat. products & resource. 2010; **1**(3): 306-313.

[23] Oranusi SU, Braide W, Umeze RU. Antimicrobial activities and chemical compositions of Chrysophyllum cainito (star apple) fruit. Microbiology Res. Intl. 2015; **3**(3):41-50.

[24] Ajiboye AE, Ameen MT, Adedayo MR. Antimicrobial activity and phytochemical screening of the fruit pulp of *Dialium guineense* (Velvet Tamarind) on some microbial isolates. J. Microbiol. & Antimicrobial. 2015; **7**(4), 33-41.