International Journal of Micro Biology, Genetics and Monocular Biology Research
Vol.7, No.1, pp.42-64, 2024
Print ISSN: ISSN 2059-9609
Online ISSN: ISSN 2059-9617
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Antimicrobial and Phytochemical Screening of Garden Eggs (*Solanum macrocarpon*) and (*Solanum aethiopicum*) Leaves and Fruit

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doi:https://doi.org/10.37745/ijmgmr.15v7n14264 Published September 30, 2024

Citation: Enyinta M.C., Bello-Hassan M, Dike O.K., Nnadi E.C., Odili C.W., and Itaman V.O. (2024) Antimicrobial and Phytochemical Screening of Garden Eggs (Solanum macrocarpon) and (Solanum aethiopicum) Leaves and Fruit, *International Journal of Micro Biology, Genetics and Monocular Biology Research*, Vol.7, No.1, pp.42-64

Abstract: There are over 25 species of egg plants in Nigeria including those domesticated for their leaves, fruits or both; eaten as vegetables or used in traditional medicine. However, *S. aethiopicum* and *S. macrocarpon* are the most cultivated and most utilized in Nigeria. Antimicrobial activities and phytochemical screening of *S. aethiopicum* and *S. macrocarpon* were studied. The antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test organisms showed higher zones of inhibition than aqueous extracts. The qualitative analysis of the phytochemicals present in *S. aethiopicum* showed higher content of saponin 46.10 +0.61 ^{b} than glycoside 0.05 +0.00 ^{d} on the fruit extracts while on the leaves extracts tanin 13.73 +0.21 ^{c} was more present than phenol 0.21 +0.01 ^{a} while the qualitative analysis of the phytochemicals present in *S. macrocarpon* showed that Alkaloid 20.22^{c} +0.01 was more active than glycoside 0.05^{d} +0.00 on the fruit extracts while on the leaves extracts saponin 18.73^{c} +0.21 was more present than phenol 0.21^{a} +0.01. In conclusion, the experimental results have revealed that the two species of African eggplant are nutritionally and therapeutically valuable and can be developed as functional foods having both nutritional and medicinal benefits to consumers.

Keywords: Antimicrobial, Antioxidant, Extracts, Phytochemical Composition of Solanum macrocarpon (Garden Eggs) and Solanum aethiopicum (Ethopian Garden Egg)

INTRODUCTION

Vegetables are important diet as they are low in cholesterols, low in saturated fats and contain essential fat requirements. They are also good sources of crude fibers and hence good laxative (Oyenuga *et al.,* 2015). Vegetables have medicinal values as they help to neutralize stomach acidity and aid digestion (Yakubu *et al.*, 2015). They provide essential mineral elements (Oyenuga *et al.,* 2015). Fruits are important sources of vitamins and carbohydrate like fibre and sugar. They are low in calories and naturally sweet. Fruits and their juices are good sources of water too. Nutrients found in fruits and some plant extracts do more than just prevent deficiency diseases. Certain vitamins or vitamin precursors in produce, notably vitamin C, B and carotene, as well as polyphenols are powerful antioxidants (Ilodibia *et al.*, 2014).

African eggplants (*Solanum macrocarpon*), popularly known as garden eggs, are an important vegetable cultivated in tropical Africa, tropical Asia, and tropical America, as well as throughout tropical and subtropical areas (Tindal, 2019). They are consumed in various regions of the world where they are found. The parts of the plant consumed are the fruits and young leaves, which, despite their bitter taste, have a high nutrient yield. The roots, leaves, and fruits of *Solanum macrocarpon* possess medicinal properties. Wide variations exist within the vegetative and fruit characters, both within and between African eggplant species, including variations in characters like corolla diameter, petiole length, leaf blade width, plant branching, fruit shape, and fruit color. Their uses in indigenous medicine range from weight reduction to treatment of several ailments, including asthma, allergic rhinitis, nasal catarrh, skin infections, rheumatic disease, swollen joint pains, gastro-esophageal reflux disease, constipation, and dyspepsia (Oyenuga *et al.,* 2015). Several studies support the folkloric use of the plants in local foods and medicinal preparations; for instance, different researchers have reported significant analgesic, anti-inflammatory, anti-asthmatic, anti-glaucoma, hypoglycemic, hypolipidemic, and weight reduction effects of eggplants, particularly S. melongena, on test animals and humans (Oyenuga *et al.,* 2015). These pharmacological properties have been attributed to the presence of certain chemical substances in the plants, such as fiber, ascorbic acid, phenols, anthocyanin, glycoalkaloids, and α-chaconine (Oyenuga *et al.,* 2015). This study shows the antimicrobial and phytochemical screening of garden eggs (*Solanum macrocarpon*) and (*Solanum aethiopicum*) leaves and fruit.

Experimental Procedure

Materials and Method

Plant Materials

Fresh leaves and fruits of garden eggs (*Solanum macrocarpon* and *S. aethiopicum*) were collected from the orchard of National Root Crops Research Institute, Umudike, Abia State, South–East of Nigeria. The authentication of the plant materials was done by Prof. G.G Osuagwu in the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia State. It was ensured that the fruits and leaves were healthy and uninfected. The fruits were washed thoroughly under running tap water to eliminate dust and foreign particles after which they will be cut aseptically into small pieces, air-dried and grounded into powdery form using sterile manual grinder. They were then stored in a cool, dry place prior to extraction process.

Extraction Procedures

The leaves and fruits of garden egg (*Solanum macrocarpon* and *S. aethiopicum*) were cut into bits with a knife and air dried for 12 h to remove all moisture. The samples were grinded into fine powdered form.

Ethanol and Aqueous Extraction

Ethanol and aqueous extracts of the *Solanum macrocarpon* and *S. aethiopicum* samples were prepared using the method described by Oyagade *et al*. (2001). Ethanol and aqueous extraction of the plant materials were carried out by suspending 50 g of pulverized leaf samples in 200 ml of 95% ethanol and 200ml of water respectively. The ethanol and aqueous extraction were done at room temperature and the extracts were decanted and filtered through Whatman filter paper No 10. The filtered extracts were sterilized using membrane filter and evaporated to dryness at 40^{o}C. The crude ethanol and aqueous extract were stored at 4°C until required. This was used for phytochemical and antimicrobial analysis.

Preparation of Media

The media used for this study were MacConkey agar (MA), Nutrient agar (NA) Muller-Hinton agar (MHA) and Sabouraud Dextrose agar (SDA). They were prepared according to the manufacture's instructions.

Microorganisms

Clinical bacterial and yeast isolates which include *Escherichia coli, Staphylococcus aureus,, Salmonella* sp, *Klebsiella* sp *Aspergillus niger* and *Candida albicans* were obtained from, Microbiology Laboratory stocks in Michael Okpara University of agriculture Umudike, Abia State, Nigeria. Confirmation tests were carried out on the organisms according to the method of (Cheesbrough, 2004).

Antimicrobial Activity

Sensitivity screening was carried out by the method of (Bauer, 2000). Antimicrobial activities of the extract were tested using Mueller-Hinton Agar (MHA) and Potatoes Dextrose Agar supplemented with 0.05mg/ml of chloramphenicol. The ability of the various extracts to inhibit the growth of the test organisms was determined using the agar well technique**.** Sterile Muller Hilton agar plates were prepared and allowed to solidify. Standardized organism in nutrient broth of 24 hours culture was inoculated into the plates. A sterile Cork borer of 5mm diameters was used to make 5 holes on the plates. Varying concentrations of the extracts, i.e. 200, 100, 50 and 25 mg/ml were made and 0.1ml of each extract were placed and ciprofloxacin (5µg/ml) for the bacterial test organisms and fluconazole (25µg/ml) for the fungal test organisms served as positive control. The plates were duplicated and left on the bench for few minutes for the extract to diffuse into the agar and then incubated at 37°C for 24 hours for bacteria while the fungi were incubated at 28^0C for 3-5 days. After incubation the zone of clearance around each hole was measured using a metric ruler by taking measurement from the edge of the plate to the point where the growth of the organism started. The diameter of the zone of inhibition which represents antibacterial activity was measure in (mm) using a ruler (Bauer, 2000).

Determination of minimum inhibitory concentration (MIC)

The minimum inhibitory concentration (MIC) of the aqueous and ethanol extracts was determined for each of the test organisms at varying concentrations of 200, 100, 50 and 25and mg/ml). Two milliliter (2 ml) of nutrient broth was pipette into each sterilized test tubes and two milliliter (2 ml) of crude extracts added to the first test tube, then double fold dilution was performed. Then one milliliter (1 ml) of the test organism previously diluted to 0.5 McFarland turbidity standard was introduced to the tubes. A tube containing nutrient broth only was seeded with the test organism to serve as control. All the tubes were then incubated at 37^0C for 24 hours and then examined for growth by observing for turbidity (Kaya *et al*. 2012).

Determination of Minimum Bactericidal and Fungicidal Concentrations (MBC and MFC)

From the tubes showing no visible growth in MIC, 0.1 ml of the suspension was inoculated onto sterile Nutrient agar and Potatoes Dextrose Agar, for bacterial and fungal respectively. The plates were incubated at 37^0C for 24hours, the least concentration that did not show any visible growth of the test microorganism was considered as the MBC for the bacterial organisms and MFC for the yeast. A plate with media only was set as negative control to check the sterility of the media (Ajaiyeoba *et al*., 2003).

Phytochemical Screening

Determination of Flavonoids

Flavonoid was determined using the method described by (Harborne, 2000). A measure weight of the sample (5g) was boiled in 100ml 0f 2 M HCL solutions under reflex for 40mins. It was allowed to cool before being filtered. The filtrate was treated with equal volume of ethyl acetate and mixture was transferred to a separation funnel. The flavonoid extract (contained in the ethyl acetate portion) was received by filtration using weighed filter paper. The weight was obtained after drying in the oven and cooling in desiccator. The weight was expressed as percentage of the weight analyzed.

Determination of Phenols

This was determined by the Folin- Ciosptean spectrophotometer (AOAC 2005). The total phenol was extracted in 200mg of the sample with 100ml concentrated methanol. The mixture was shaken for 30mins at room temperature. The mixture was centrifuged at 500rpm for 15mins and the supernatant (extract) was used for the analysis. 1ml portion of the extract from each sample was treated with equal volume of Folin-Ciosptean reagent followed by the addition of 2mls of 20% Na_2CO_3 solution. Standard phenol solution was prepared and diluted to a desired concentration. I ml of the standard solution was also treated with the Folin Denis reagent. Blue coloration was measured (absorbance) in a color meter at 500mm wavelength.

Determination of Saponins

This was done by the double solvent extraction gravimetric methods (Harborne. 2000). Five grams (5g) of the sample was mixed with 50ml of 20% aqueous ethanol solution and incubated for 12 hours at a temperature of 55ºC with constant agitation. After that the mixture was filtered through. What man 4 grades of filter paper. The residue was re-extracted with 50ml of the ethanol solution for 30 minutes and the extracts weighed together.

The combined extract was reduced to about 40ml by evaporation and then transferred to a separating funnel and equal volume (40ml) of diethyl ether was added as to it. The aqueous layer was recovered while the ether was discarded. The purification process was repeated. This aqueous layer was re-extracted with the ether after which its pH was reduced to 5 with drop wise addition to dilute NaOH solution. Saponin in the extract was taken up in successive extraction with 60ml and 30ml portion of normal butanol. The combine extract (ppt) was washed with 5% NaCl solution and evaporated to dryness in a previously weighed evaporating dish. The samponin was then dried in the oven at 60^{o}C (to remove any residual solvent) cooled in a desiccator and re-weighed. The saponin was determined and calculated as a percentage of the original samples.

Determination of Tannins

This was determined by Folin Denis colorimetric method. Five grams (5g) of the powered sample was put inside a volumetric flask and50ml of distilled water was dispensed inside the volumetric flask. The mixture was shaken for 30 minutes at room temperature and filtered to obtain the extract. A standard tannic acid solution was prepared. 2ml of the standard solution and equal volume of distilled water were dispersed into a separate 50ml volumetric flasks to serve as a standard and reagent blank respectively. Then 2ml of each of the sample extract was in their respective labeled flask. The content of each flask was mixed with 35ml distilled water and 1ml of the Folin Denis reagent was added to each. This was followed by 2.5ml of saturated Na_2CO_3 solution. Therefore, each flask was diluted to the 50ml mark with distilled water and incubated for 90 minutes at room temperature. Their absorbance was measured at 760nm in a spectrophotometer with the reagent blank at Zero.

Determination of Alkaloids

The alkaline precipitation gravimetric method (Harborne, 2000) was used. A measured weight of the processed sample (5g) was dispersed in 100mls of 10% acetic acid in ethanol solution. The mixture was well shaken and allowed to stand for 4 hours at room temperature being shaken every 30min. At the end of this period, the mixture was filtered through. Whatman No 42 grade of filter paper. The filtrate (extract) was concentrated by evaporation: to a quarter of its original volume. The extract was treated with drop-wise addition of concentrate NII_3 solution to precipitate the alkaloid. The addition was continued until the NII_3 was in excess. The alkaloid precipitate was removed by filtration using weighed what-man No 42-filter paper. After washing with 1% NH_4OH solution, the precipitate in the filter paper was dried at 60^{o}C and re-weighed after cooling in a desiccator.

Determination of Steroids

This was determined quantitatively using the method described by association of official analytical chemist (AOAC, 2005). 5g of plant leaf samples was dispersed into 100ml of distilled water and homogenized in a blender. The homogenate was filtered and the filtrate was eluted with ammonium hydroxide solution. 1 ml of the mixture and 3 drops of concentrated H_2SO_4 was cautiously added to cool. Standard sterol solution was prepared to serve as standard and blank. The absorbance of standard and prepared sample was measured in a spectrophotometer at 420nm. The blank reagent was used to calibrate the instrument at Zero. This experiment was repeated two times to get an average.

RESULTS

Antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test bacteria

The antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test organisms showed that *Klebsiella pneumonia* 19.50 ± 0.30^{c} had the highest diameter zone of inhibition than *Salmonella* 10.58 ± 0.33^{ab} which showed lowest range of inhibition while on the fruit extracts it showed that *E.coli* had the highest zone of inhibition 21.67 ± 0.20^{ab} followed by *Klebsiella pneumonia* 12.00 ± 1.00^{ab} which had the lowest zone of inhibition as shown in table 1.

Table 1. Antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test bacteria

Leaves Extract	**Concentration (mg/ml)**				
	200 (mg/ml)	**150 (mg/ml)**	**100 (mg/ml)**	**50 (mg/ml)**	**Control Ciprofloxacin**
S. aureus	15.50±0.28[a]	-	-	-	26.66±0.35 [ab]
E. coli	16.80±0.37[b]	-	-	-	22.76±0.43 [cd]
Klebsiella pneumonia	19.50±0.30[c]	15.33±0.33[b]	-	-	29.92±0.15 [ab]
Salmonella sp	16.58±0.33[d]	-	-	10.58±0.33 [ab]	24.59±0.32 [cd]
Fruit Extract					
S. aureus	14.70±0.43[a]	16.58±0.33 [ab]	12.23±0.24[d]	12.40±0.23 [c]	18.97±0.43 [d]
E. coli	13.67± 0.58[c]	-	-	21.67±0.20 [ab]	22.76±0.43 [ab]
Klebsiella pneumonia	-	-	12.23±0.24[c]	12.00 ± 1.00 [ab]	14.67 ± 0.58 [de]
Salmonella sp	12.67 ± 0.58 [b]	16.04±0.19 [f]	12.40±0.23[e]	14.67 ± 0.58 [de]	26.66±0.35 [de]

Superscript shows level of significance. Similar superscripts mean: No significance Different subscripts=significant difference.

Antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test bacteria

The antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test organisms showed that *S. aureus* 23.56±0.46 [ab] had the highest diameter zone of inhibition than *Klebsiella pneumonia* 12.70±0.17 [cd] which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Salmonella* sp 21.67±0.20 [ab] had the

highest zone of inhibition followed by *S. aureus* 12.00±0.04 ^{bc} which had the lowest range of inhibition shown in table 2.

Table 2. Antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test bacteria

Leaves Extract	Concentration (mg/ml)				
	200 (mg/ml)	150 (mg/ml)	100 (mg/ml)	50 (mg/ml)	Control Ciprofloxacin
S. aureus	23.56±0.46 ^{ab}	15.88±0.49 ^{bc}	-	-	26.66±0.35 ^{de}
E. coli	16.80±0.37 ^{de}	21.33±0.70 ^{ab}	18.40±0.32 ^{bc}	14.40±0.45 ^{ab}	22.76±0.43 ^{bc}
Klebsiella pneumonia	18.16±0.81 ^{ab}	19.50±0.28 ^{bc}	15.76±0.39 ^{ab}	12.70±0.17 ^{cd}	29.92±0.15 ^{cd}
Salmonella sp	16.93±0.17 ^{bc}	16.10±0.43 ^{cd}	-	-	24.59±0.32 ^{de}
Fruit Extracts					
S. aureus	16.58±0.33 ^{cd}	12.00±0.04 ^{bc}	-	-	18.97±0.43 ^{a}
E. coli	18.97±0.43 ^{ab}	15.61±0.36 ^{bc}	-	-	22.76±0.43 ^{a}
Klebsiella pneumonia	-	-	12.23^{c}±0.24	12.00^{ab} ± 1.00	14.67 ± 0.58 ^{de}
Salmonella sp	21.67±0.20 ^{ab}	16.04±0.19 ^{ab}	12.40±0.23 ^{c}	-	26.66±0.35 ^{b}

Superscript shows level of significance. Similar superscripts means: No significance Different subscripts=significant difference.

Antimicrobial activities of aqueous extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test bacteria

The antimicrobial activities of aqueous extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test organisms showed that *E.coli* 26.33±0.70 ^{ab} had the highest diameter zone of inhibition than *Klebsiella pneumonia* 12.70±0.17 ^{cd} which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Klebsiella pneumonia*19.00 ± 1.00 ^{ab} had

the highest zone of inhibition followed by *S.aureus* 10.50±0.33^{cd} which had the lowest range of inhibition shown in table 3.

Table 3. Antimicrobial activities of aqueous extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test bacteria

Leaves Extract	Concentration (mg/ml)				
	200 (mg/ml)	150 (mg/ml)	100 (mg/ml)	50 (mg/ml)	Control Ciprofloxacin
S. aureus	18.56±0.46^{ab}	15.88±0.49^{bc}	-	-	26.66±0.35^{de}
E. coli	16.80±0.37^{de}	26.33±0.70^{ab}	18.40±0.32^{bc}	14.40±0.45^{ab}	22.76±0.43^{bc}
Klebsiella pneumonia	21.33±0.81^{ab}	19.50±0.28^{bc}	15.76±0.39^{bc}	12.70±0.17^{cd}	29.92±0.15^{cd}
Salmonella sp	16.93±0.17^{bc}	16.10±0.43^{cd}	-	-	24.59±0.32^{de}
Fruit Extracts					
S. aureus	10.50±0.33^{cd}	12.23±0.24^{bc}	-	-	16.97±0.43^{a}
E. coli	18.97±0.43^{ab}	15.61±0.36^{bc}	-	-	20.76±0.43^{a}
Klebsiella pneumonia	-	-	18.23±0.24^{c}	19.00 ± 1.00^{ab}	19.67 ± 0.58^{de}
Salmonella sp	16.67±0.20^{ab}	15.04±0.19^{ab}	18.40±0.23^{c}	-	30.66±0.35^{b}

Superscript shows level of significance. Similar superscripts means: No significance Different subscripts=significant difference.

Antimicrobial activities of aqueous extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test bacteria

The antimicrobial activities of aqueous extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test organisms showed that *E.coli* 21.33±0.70^{ab} had the highest diameter zone of inhibition than *Salmonella* 10.10±0.43^{cd} which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Salmonella* 21.67±0.20^{ab} had the highest zone of inhibition followed by *Klebsiella pneumonia* 12.00 ± 1.00^{ab} which had the lowest range of inhibition shown in table 4.

Table 4. Antimicrobial activities of aqueous extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test bacteria

Leaves Extract	Concentration (mg/ml)				
	200 (mg/ml)	**150 (mg/ml)**	**100 (mg/ml)**	**50 (mg/ml)**	**Control Ciprofloxacin**
S. aureus	16.50±0.46 ^{ab}	10.81±0.49 ^{bc}	-	-	20.66±0.35 ^{de}
E. coli	16.80±0.37 ^{de}	21.33±0.70 ^{ab}	18.40±0.32 ^{bc}	14.40±0.45 ^{ab}	26.76±0.43 ^{bc}
Klebsiella pneumonia	12.16±0.81 ^{ab}	19.50±0.28 ^{bc}	15.76±0.39 ^{bc}	12.70±0.17 ^{ab}	29.53±0.15 ^{cd}
Salmonella sp	14.90±0.17 ^{bc}	10.10±0.43 ^{cd}	-	-	21.59±0.32 ^{de}
Fruit Extracts					
S. aureus	16.58±0.33 ^{cd}	12.23±0.24 ^{bc}	-	-	18.97±0.43 ^{a}
E. coli	18.97±0.43 ^{ab}	15.61±0.36 ^{bc}	-	-	17.76±0.43 ^{a}
Klebsiella pneumonia	-	-	12.23±0.24 ^{c}	12.00 ± 1.00 ^{ab}	11.67 ± 0.58 ^{de}
Salmonella sp	21.67±0.20 ^{ab}	16.04±0.19 ^{ab}	12.40±0.23 ^{c}	-	15.66±0.35 ^{b}

Superscript shows level of significance. Similar superscripts means: No significance Different subscripts=significant difference.

Antimicrobial activities of aqueous and ethanolic extracts of Garden Eggs (*Solanum macrocarpon* and *aethiopicum*) leaves and fruits against test fungi

The antimicrobial activities of aqueous extract of Garden Eggs (*Solanum macrocarpon* and *aethiopicum*) leaves and fruits against test organisms showed that *Candida albican* 21.33±0.70 ^{ab} had the highest diameter zone of inhibition than *Aspergillus niger* 10.81^{bc}±0.49 which showed lowest range of inhibition as on the leaves extracts the fruit extracts showed that *Aspergillus niger* 18.46±0.24 ^{ab} had highest zone of inhibition than *Candida albican* 11.52 ^{de} ±0. The Aqueous extracts of *S. aethiopicum* showed that *Aspergillus niger*18.97^{ab}±0.43 had more activity than *Candida albican* 12.23±0.24 ^{bc} while the fruit extracts showed that Candida albican 25.10±0.17 ^{b} had more activity than *Aspergillus niger* 10.16±0.16 ^{ab}.

Table 5. Antimicrobial activities of aqueous and ethanolic extracts of Garden Eggs (*Solanum macrocarpon* and *aethiopicum*) leaves and fruits against test fungi

Superscript shows level of significance. Similar superscripts means: No significance Different subscripts=significant difference

Aqueous Leaves Extract *Solanum macrocarpon*	**Concentration (mg/ml) 200 (mg/ml)**	**150 (mg/ml)**	**100 (mg/ml)**	**50 (mg/ml)**	**Control Fluconazol**
Aspergillus niger	16.50±0.46 ^{ab}	10.81±0.49 ^{bc}	-	-	20.66±0.35 ^{de}
Candida albican	16.80±0.37 ^{de}	21.33±0.70 ^{ab}	18.40±0.32 ^{bc}	14.40±0.45 ^{ab}	26.76±0.43 ^{bc}
Ethanolic Leaves Extract					
Aspergillus niger	18.46±0.24 ^{ab}	12.06±0.12 ^{cd}	-	-	26.66±0.35 ^{ab}
Candida albicans	15.23 ±0.20 ^{bc}	11.52±0.14 ^{de}	-	-	24.59±0.32 ^{bc}
Aqueous leaves Extract *S. aethiopicum*					
Aspergillus niger	16.58±0.33 ^{cd}	12.23±0.24 ^{bc}	-	-	18.97±0.43 ^{a}
Candida albicans	18.97±0.43 ^{ab}	15.61±0.36 ^{bc}	-	-	17.76±0.43 ^{a}
Ethanolic Fruit Extract					
Aspergillus niger	22.76±0.43 ^{a}	22.60±0.21 ^{b}	19.31±0.17 ^{d}	10.16±0.16 ^{ab}	24.59±0.32 ^{cd}
Candida albicans	25.10^{b} ±0.17	20.83^{c}±0.08	16.06^{e}±0.20	-	22.76^{bc}±0.43

Table 6. Minimum Inhibitory Concentration (MIC) Of Aqueous and Ethanol Extracts Of Garden Egg (*Solanum aethiopicum*) Leaves And Fruits Against Test Organisms

The minimum inhibitory concentrations (MIC) of the aqueous and ethanol extract of Garden Eggs (Solanum *aethiopicum*) Leaves and Fruits against test organisms are presented in (Tables 6). The *Solanum aethiopicum* leaves and fruit had minimum inhibition concentration (MIC) values range from 100 mg/ml to 50mg/ml concentration against test organisms.

Extracts	Concentration	Test orga-nisms/Extracts											
		S .aureus		*E.coli*		*Kebsiella* sp		*Salmonella* sp		*Aspergillus niger*		*Candida albicans*	
		Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous
Leaves	200	-	-	-	-	-	-	-	+	-	+	-	-
	100	-	+	-	+	-	+	-	+	-	+	-	-
	50	-	+	+	+	+	+	-	+	-	+	-	-
	25	+	+	+	+	+	+	-	+	-	-	-	+
	12.5	+	+	-	+	+	+	+	+	-	-	-	+
	Mic value (mg/ml)	25	100	50	100	50	100	25	100	50	100	50	50
Fruit	200	-	-	-	+	-	-	-	-	-	+	+	-
	100	+	-	-	+	-	+	+	+	-	-	+	-
	50	+	+	-	-	+	+	-	+	-	-	-	+
	25	-	+	-	+	+	-	+	-	+	-	+	+
	12.5	-	+	-	+	-	-	-	-	+	+	-	-
	Mic value (mg/ml)	25	50	12.5	25	12.5	50	12.5	12.5	50	12.5	12.5	12.5

Table 6 Minimum Inhibitory Concentration (MIC) Of Aqueous and Ethanol Extracts Of Garden Egg (*Solanum aethiopicum*) Leaves And Fruits Against Test Organisms

Table 7. Minimum Inhibitory Concentration (MIC) Of Aqueous and Ethanol Extracts Of Garden Egg (*Solanum macrocarpon*) Leaves And Fruits Against Test Organisms

The minimum inhibitory concentrations (MIC) of the ethanol extract of *Solanum aethiopicum* and *macrocarpon* Leaves and Fruits against test organisms are presented in (Tables 7), Both. leaves and fruit of *aethiopicum* and *macrocarpon* had minimum inhibition concentration (MIC) values *9+6range from 50 mg/ml to 12,5mg/ml concentration against test organisms respectively.

International Journal of Micro Biology, Genetics and Monocular Biology Research
Vol.7, No.1, pp.42-64, 2024
Print ISSN: ISSN 2059-9609
Online ISSN: ISSN 2059-9617
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Extracts	Concentration	Test organisms/Extracts											
		S .aureus		*E.coli*		*Kebsiella* sp		*Salmonella* sp		*Aspergillus niger*		*Candida albicans*	
		Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous	Ethanol	Aqueous
Leaves	200	-	-	-	-	-	-	-	+	-	+	-	-
	100	-	+	-	+	-	+	-	+	-	+	-	-
	50	-	+	+	+	+	+	-	+	-	+	-	-
	25	+	+	+	+	+	+	-	+	-	-	-	+
	12.5	+	+	-	+	+	+	+	+	-	-	-	+
	MIC value (mg/ml)	25	100	50	100	50	100	25	100	50	100	50	50
Fruit	200	-	-	-	+	-	-	-	-	-	+	+	-
	100	+	-	-	+	-	+	+	+	-	-	+	-
	50	+	+	-	-	+	+	-	+	-	-	-	+
	25	-	+	-	+	+	-	+	-	+	-	+	+
	12.5	-	+	-	+	-	-	-	-	+	+	-	-
	MIC value (mg/ml)	25	50	12.5	25	12.5	50	12.5	12.5	50	12.5	12.5	12.5

Table 7. Minimum Inhibitory Concentration (MIC) Of Aqueous and Ethanol Extracts Of Garden Egg (*Solanum macrocarpon*) Leaves And Fruits Against Test Organisms

International Journal of Micro Biology, Genetics and Monocular Biology Research
Vol.7, No.1, pp.42-64, 2024
Print ISSN: ISSN 2059-9609
Online ISSN: ISSN 2059-9617
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

The minimum bactericidal/fungicidal concentration value of aqueous extract Garden Eggs (*Solanum aethiopicum* and *macrocarpon*) Leaves and Fruits against test organisms is presented in (Tables 8). The *S. macrocarpon* leaves and fruit have bactericidal and fungicidal against test microorganisms at concentration values range from 200mg/ml to 100 mg/ml, while *S. aethiopicum* leaves and fruit have Minimum bactericidal and fungicidal concentration values range from 200mg/ml .to 200mg/ml against target microorganisms.

Table 8: Minimum bactericidal and fungicidal concentration (MBC/MFC) value of aqueous extract Garden Eggs (*Solanum aethiopicum* and *macrocarpon*) Leaves and Fruits against test organisms

Test Organisms	MBC/FBC value of aqueous extract and concentration (mg/ml)			
	aethiopicum leaves		*macrocarpon* leaves	
	leaves	fruit	leaves	fruit
Staphylococcus aurea	200	200	200	100
Escherichia coli	200	200	100	100
Klebsiella pneumonia	200	200	100	100
Salmonella species	200	200	200	100
Candida albicans	200	200	100	200
Aspergillus Niger	200	200	100	200

Minimum bactericidal and fungicidal concentration (MBC/MFC) value of ethanol extract Garden Eggs (*Solanum aethiopicum* and *macrocarpon*) Leaves and Fruits against test organisms

The minimum bactericidal/fungicidal concentration value of ethanol extract Garden Eggs (*Solanum aethiopicum*) Leaves and Fruits against test organisms is presented in (Tables 9). Both *Solanum aethiopicum* and *macrocarpon* leaves and fruit have bactericidal and fungicidal (MB/MFC) values range from 100 mg/ml to 25mg/ml concentration against test organisms respectively

Table 9. Minimum bactericidal and fungicidal concentration (MBC/MFC) value of ethanol extract Garden Eggs (*Solanum aethiopicum* and *macrocarpon*) Leaves and Fruits against test organisms

Test Organisms	MBC/FBC value of ethanol extract and concentration (mg/ml)			
	aethiopicum		*macrocarpon*	
	leaves	fruit	leaves	fruit
Staphylococcus aurea	50	50	100	25
Escherichia coli	100	50	25	25
Klebsiella pneumonia	100	25	25	25
Salmonella species	50	100	50	25
Candida albicans	50	25	50	50
Aspergillus niger	100	100	50	50

Qualitative Analysis of the Phytochemicals Present in *S. aethiopicum*

The qualitative analysis of the phytochemicals presents in *S. aethiopicum* showed that saponin 46.10 +0.61 ^{b} had more activity than glycoside 0.05 +0.00 ^{d} on the fruit extracts while on the leaf's extracts tanin 13.73 +0.21 ^{c} was more present than phenol 0.21 +0.01 ^{a} as shown in table 10.

Table 10. Qualitative Analysis of the Phytochemicals Present in *S. aethiopicum*

Phytochemical	*Solanum aethiopicum* fruit	*S. aethiopicum* Leaves
Alkaloid	0.13 +0.01 ^{c}	5.47 +0.03 ^{a}
Flavonoid	1.25 +0.01 ^{d}	13.60 +0.06 ^{d}
Saponin	46.10 +0.61 ^{b}	12.73 +0.21 ^{c}
Tannin	2.95 +0.03 ^{c}	13.73 +0.21 ^{c}
Phenol	0.36 +0.00 ^{a}	0.21 +0.01 ^{a}
Glycoside	0.05 +0.00 ^{d}	13.60 +0.06 ^{d}

Qualitative Analysis of the Phytochemicals Present in *S. macrocarpon*

The qualitative analysis of the phytochemicals presents in *S. macrocarpon* showed that Alkaloid 20.22^{c} +0.01 had more activity than glycoside 0.05^{d} +0.00 on the fruit extracts while on the leaves extracts saponin 18.73^{c} +0.21 was more present than phenol 0.21^{a} +0.01 as shown in table 11.

Table 11: Qualitative Analysis of the Phytochemicals Present in *S. macrocarpon*

Phytochemical	*Solanum macrocarpon* fruit	*S. macrocarpon* Leaves
Alkaloid	20.22+0.01 [c]	15.47 +0.03 [a]
Flavonoid	11.25 +0.01 [d]	3.60 +0.06 [d]
Saponin	16.10 +0.61 [b]	18.73 +0.21 [c]
Tannin	12.95 +0.03 [c]	8.73 +0.21 [c]
Phenol	0.36 +0.00 [a]	0.21 +0.01 [a]
Glycoside	0.05 +0.00 [d]	13.60 +0.06 [d]

DISCUSSION

The fruits of *S. aethiopicum* and *S. macrocarpon* differed markedly in their shape and colour. *S. aethiopicum* are mostly dark green in colour and round in sizes whereas the fruits of *S. macrocarpon* L. are largely oval shaped with a mixture of cream white to light yellow and green with dark green stripes. The wide variations in vegetative and fruit characters both within and between *Solanum* species create ambiguity in taxonomic delineation of African eggplants (Okwu, 2016). This has often resulted in a mix-up of the identity of species of garden egg with some researchers referring to different species as varieties of one species. In this present study, The antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test organisms showed that *Klebsiella pneumonia* 19.50±0.30[c] had the highest diameter zone of inhibition than *Salmonella* 10.58±0.33 [ab] which showed lowest range of inhibition while on the fruit extracts it showed that *E.coli* had the highest zone of inhibition 21.67±0.20 [ab] followed by *Klebsiella pneumonia* 12.00 ± 1.00[ab] which had the lowest zone of inhibition. This result is in agreement with previous reports of references (Chuwkwu *et al*., 2002). These findings support the traditional knowledge of local users and it is a preliminary, scientific and validation for the use of garden egg fruits for antimicrobial activity to promote proper conservation and sustainable use of the plant resources. Awareness of local community should be enhanced incorporating the traditional knowledge with scientific findings.

The antimicrobial activities of ethanolic extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test organisms showed that *S. aureus* 23.56±0.46 [ab] had the highest diameter zone of inhibition than *Klebsiella pneumonia* 12.70±0.17[cd] which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Salmonella* sp 21.67±0.20 [ab] had the highest zone of inhibition followed by *S. aureus* 12.00±0.04 [bc] which had the lowest range of inhibition.

The antimicrobial activities of aqueous extract of Garden Eggs (*Solanum aethiopicum*) leaves and fruits against test organisms showed that *E.coli* 26.33±0.70 ^{ab} had the highest diameter zone of inhibition than *Klebsiella pneumonia* 12.70±0.17 ^{cd} which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Klebsiella pneumonia*19.00 ± 1.00 ^{ab} had the highest zone of inhibition followed by *S.aureus* 10.50±0.33^{cd} which had the lowest range of inhibition.

The antimicrobial activities of aqueous extract of Garden Eggs (*Solanum macrocarpon*) leaves and fruits against test organisms showed that *E.coli* 21.33±0.70 ^{ab} had the highest diameter zone of inhibition than *Salmonella* 10.10±0.43 ^{cd} which showed lowest range of inhibition as on the leaves extracts while the fruit extracts showed that *Salmonella* 21.67±0.20 ^{ab} had the highest zone of inhibition followed by *Klebsiella pneumonia* 12.00 ± 1.00 ^{ab} which had the lowest range of inhibition.

The result of this study showed that the ethanol leaves and seed extract of *Solanum macrocarpon* inhibited the growth of all the microbial isolated tested at high concentration. This suggests that the leaves and fruit extracts have antimicrobial activity. The extracts are equally broad spectrum in activity as their activities were independent of Gram reaction. In comparison to the work of Omodamiro *et al*. (2008), their ethanolic extract of *Solanum macrocarpon* show strong inhibitory activity against all the test isolates including *Pseudomonas aeruginosa, Escherichia coli, Proteus mirabilis and Staphylococcus aureus;* while in this present study, the aqueous extract of *P. guineense*, generally, showed less antimicrobial activity than the ethanol extract against the isolates. This observed difference may be due to insolubility of the active compounds in water or the presence of inhibitors to the antimicrobial components (Okigbo *et al.,* 2006). The less activity of water extract than ethanol extract against most microbial strains investigated in this study is in agreement with previous works which showed that aqueous extracts of plants generally showed little or no antibacterial activities (Aliero *et al.,* 2006; Ashafa *et al.,* 2000; Amadioha *et al.,*1999), (Okigbo *et al.,* 2005) reported that inactivity of plant extracts may be due to age of plant, extracting solvents method of extraction and time of harvesting of plant materials. From the result there is a variation in the degrees of antimicrobial activities of the extracts on the isolates. The variation is presumed to be due to differences in response by the isolates to different active compounds present in the plant.

CONCLUSION

The variations that occur in the eggplants cultivars do not end at the morphological level only but also in the composition of the various nutrients and bioactive substances present in them. Eggplants have appreciable contents of nutrients and phytochemicals which make them nutritionally and therapeutically beneficial.

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