Compositional Analysis, Antioxidant and Antimicrobial Potential of the Seed Extract of Annona cinerea Dunal Grown in Nigeria

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Received: 6 December 2019 Accepted: 1 January 2020 Published: 15 January 2020

Abstract

Seed of Annona cinerea grown in Nigeria was investigated for its secondary metabolites and antioxidant potential using Gas Chromatography-Mass Spectrometry (GC-MS), 2,2?-dyphenyl-1-picrylhydrazyl (DPPH) and 2,6-ditert-butyl-4-[(3,5-ditert-butyl-4-?1-oxidanylphenyl)methylidene] cyclohexa-2,5-dien-1-one (Galvinoxyl), respectively. The antibacterial activity of the seed extract was evaluated on eleven (11) pathogenic bacteria using agar well diffusion method at different concentrations of the extract. Twenty-seven (27) therapeutically active secondary metabolites were identified in the seed extract using GC-MS and the principal constituents identified were 3-O-methyl-d-glucose (52.14

Index terms— Annona cinerea, phytochemical, free radical scavenging, antimicrobial activities.

1 Introduction

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these natural antioxidants in medicinal plants against oxidative stress induced diseases and disorders (Lawal et al., 2016;Bourhia et al., 2019;Shaito et al., 2020). Presence of scientific literature on antioxidants and antimicrobial activity of phytochemicals to a great extent validates the traditional claims about the usefulness of these medicinal plants to treat reactive oxygen species (ROS) induced health related disorder (Liu et al., 2018;Khameneh et al., 2019). Free radicals such as reactive oxygen species (ROS) are usually produced as a result of an organism's normal use of oxygen. An imbalance between formation and removal of these free radicals can lead to a pathological condition called oxidative stress resulting in many physiological processes like aging and chronic diseases (Aprioku, 2013;Phaniendra et al., 2015). However, the human body employs antioxidants to counteract these free radicals thus repairing free radical damage by initiating cell regeneration or cell repair (Lobo et al., 2010;He et al., 2017;Pizzino et al., 2017). Daily consumption of natural products that are rich in antioxidants, such as vegetables and fruits play an important role in the prevention and treatment of oxidative stress-related diseases such as cancer, arthritis, liver injury, diabetes, Alzheimer's disease, cardiovascular problems, neurodegenerative disorders, and various inflammatory illnesses (Tan et al., 2018;Mattia et al., 2019). Incorporation of antioxidant compounds by consuming natural products in the daily diet can be a suitable solution to solving human health issues. These natural antioxidant sources can be used as a preventive medicine. Recent researches showed that there is an inverse link between the dietary consumption of antioxidant-rich foods and prevalence of human illness (Arulselvan et al., 2016;Wilson et al., 2017;Liu et al., 2018;Lourenco et al., 2019;Villaverde et al., 2019). Moreover, the use of natural products as antibiotic agents is been given more attention due to the various side effects and increasing antibiotic resistance to synthetic antibiotics observed in some pathogens responsible for food borne and other illnesses (Fair and Tor, 2014;Barbieri et al., 2017;Cheesman et al., 2017;Albaridi, 2019;Dilbato et al., 2019). Natural antimicrobials seems to be the most promising solution to many of the increasing concerns regarding antibiotic resistance and could yield better method at different concentrations of the extract. Twentyseven (27) therapeutically active secondary metabolites were identified in the seed extract using GC-MS and the principal

constituents identified were 3-O-methyl-d-glucose (52.14%), ?sitosterol (11.79%), desulphosinigrin (6.16%) and ?-tocopherol (5.84%). The extract also displayed high DPPH and galvinoxyl radical scavenging activity with IC 50 values of 5.0 and 100 ?gml -1 . The zones of inhibition ranged from 10-30 mm against all tested bacteria. The antibacterial index (AI) ranged between 0.5-25. This study demonstrated that the seed of A. cinerea could be a potential source of natural antioxidants and antimicrobial agents. edicinal plants are of great importance to the health of humans. The medicinal value of green plants lies in the ability of some secondary metabolites to produce a definite physiological action in the human body **??**Dwivedi et al., Tyers and Wright, 2019). Therefore, novel types of effective and healthy antimicrobial compounds that could protect food against contamination and consumer against infection is in high demand. Compounds derived from natural sources have the potential to be used for food safety due to their antimicrobial properties against a broad range of foodborne pathogens (Lucera et al., 2012;Hintz et al., 2015;Quinto et al., 2019).

To the best of our knowledge, there is no enough scientific information on the chemical composition and medicinal properties of seed of A. cinerea grown in Nigeria so far. Therefore, the present research was undertaken to screen extract of the seed of A. cinerea grown in Nigeria for its chemical composition, antioxidant and antimicrobial potentials.

2 II.

3 Materials and Methods

4 a) Collection of Plant Sample

The plant material was collected in Ota, Ogun State, Nigeria and it was identified as Annona cinerea Dunal.

5 b) Preparation and Extraction of the Plant Sample

Air-dried and pulverised seed were soaked in a mixture of methanol/ethyl acetate (2:1). The mixture was left for at least three days. The filtrate was concentrated using a water bath. The concentrated extract was put into a vial and stored in a refrigerator to prevent contamination pending subsequent analysis (Emmanuel et al., 2014).

6 c) Gas Chromatography-Mass Spectroscopy Analysis of the Extract for Various Secondary Metabolites

The qualitative and quantitative analysis of the secondary metabolites in the extract was carried out using GC-MS QP2010 Plus (Shimadzu, Kyoto, Japan) system at the Shimadzu Training Centre for Analytical Instruments (STC) Lagos, Nigeria. The analytical specifications of the GC-MS were done as described in

7 d) In vitro Antioxidant Activities

The antioxidant capacity of the seed extract of A. cinerea was tested using two different methods.

8 i. In vitro 2,2?-Diphenyl-1-picryl-hydrazyl Assay

The antioxidant and free radical scavenging of the extract of A. cinerea were measured by using 2, 2?diphenyl-1-picryl-hydrazyl according to the method decribed by Lin et al., (2018) with minor modification. Briefly, the reaction mixture (2.0 ml) consists of 2.0 ml of 0.1 mM DPPH prepared by dissolving 4 mg of DPPH in 100ml of methanol and then 1.0 ml of various concentrations of the extract. It was incubated for 30 min. in the dark, and the absorbance was measured at 517 nm using SM 7504 UV Spectrophotometer. The blank contained a preparation of DPPH and methanol in place of extract. In this assay, the positive control was ascorbic acid. The percentage of the radical inhibition activity was evaluated based on the following expression:

Where: A blank and A ext are the absorbance value for the blank and extract solution, respectively. The doseresponse curve was plotted and IC 50 value for the extract and the standard were calculated.

9 ii. In vitro 2,6-ditert-butyl-4-[(3,5-ditert-butyl-4-?1-oxidanylphenyl)methylidene]cyclohexa-2,5-dien-1-one (Galvinoxyl), respectively.

The antioxidant and free radical scavenging of the seed extract of A. cinerea were also evaluated using galvinoxyl according to the method previously described by Amira et al., (2012) with slight modification. Briefly, the reaction mixture with a total volume of 2.0 ml consists of 1.0 ml of 0.1mM Galvinoxyl which was prepared by dissolving 4.2 mg of Galvinoxyl in 100 ml of methanol and then 1.0 ml of various concentrations of the extract, was incubated for at least 30 min. in the dark, and then the absorbance was measured at 429 nm using SM 7504 UV Spectrophotometer. The blank was prepared by galvinoxyl and methanol in place of sample. In this assay, the positive control was ascorbic acid. The percentage of the radical inhibition activity was calculated based on the following expression: an earlier study (Ololade et al., 2014).

A blank and A ext are the absorbance value for the blank and extract solutions, respectively. The dose-response curve was plotted and IC 50 value for the extract and the standard were calculated. Antioxidant Activity Index (AAI): The AAI was calculated as: AAI was classified as weak; when AAI < 0.5; moderate, when AAI ranged between 0.5-1.0; strong; when AAI ranged between 1.0-2.0; and very strong; when AAI > 2.0.

10 e) In vitro Screening of Antibacterial Potential

Antibacterial assay of the extract at different concentrations was performed using agar well diffusion assay on sterilized Mueller Hinton Agar (MHA) using streak plate method according to the method previously used by Debalke et al., (2018). Gram-positive bacteria used for the antibacterial test were Bacillus sp, Enterococcus faecalis, Micrococcus varians and Streptococcus agalactiae while the Gram-negative bacteria were Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, Providencia stuartii, Salmonella typhimurium, Serratia marcescens and Shigella dysenteriae. Cefuroxime (CRX) 30 ?g/disc was used as positive control. After incubation for 18-24 hr at 37 o C, plates were observed for the formation of a clear zone around the well which corresponds to the antimicrobial activity of tested compounds. The zone of inhibition (ZI) was observed and measured in millimetre (mm) using transparent ruler.

11 f) Determination of the Antibacterial Activity Index (AI)

The AI of the test seed extract with respect to the positive control was done according to the method previously used by Ololade et al., 2020. The total ion chromatogram (TIC) of the methanol/ethyl acetate seed extract, showing the GC-MS profile of the compounds identified is as shown in Figure 1. The peaks in the chromatogram were integrated and compared with the database of spectrum of known components stored in the GC-MS NIST library. Phytochemical screening by GC-MS analysis of the seed extract of A. cinerea revealed the presence of different classes of organic compounds. A total of twenty-seven (**??**7) phytochemicals were identified in the seed extract accounting for 99.45% of the extract (Table 1), and the main constituents identified were 3-Omethyl-d-glucose (52.14%), ?-sitosterol (11.79%), desulphosinigrin (6.16%) and ?-tocopherol (5.84%). Previous studies on the chemical composition of leaf extract of A. muricata from Uganda showed the presence of Z-7-tetradecenal (9.39%), n-hexadecanoic acid (7.12%), oleryl alcohol (6.15%), phytol (5.61%) as its main constituents (Gavamukulya et al., 2015). 3-Omethyl-d-glucose is used as a marker to assess glucose transport by evaluating its uptake within various cells and organ systems.

12 III.

13 Results and Discussion

14 Compound

Retention Index

Percentage

15) Evaluation of Free Radical Scavenging and Antioxidant Capacity

For the evaluation of the antioxidant capacity, different assays were used to obtain valid results, this is due to the fact that antioxidant compounds present different mechanisms of reactions with the possibility of having synergistic interactions depending on the type of assay used. In this study, the antioxidant potential of the seed extract of A. cinerea was evaluated using the DPPH and the galvinoxyl assays (Table 2).

16 i. In vitro DPPH Free Radical Scavenging and Antioxidant Potentials

The results of DPPH radical scavenging assay of seed of A. cinerea grown in Nigeria is as shown in Table 2. The seed extract showed concentrationdependent increases in radical scavenging potential. The extract was evaluated at the concentrations of 1000, 500, 250, 125 and 100 ?gml -1 and with percentage free radical scavenging of 90, 89, 88, 88 and 87%, respectively. The seed exhibited low inhibition concentration (IC 50) of 5.0 ?gml -1 and antioxidant activity index (AAI) of 8.0. The IC 50 values represent the concentration at which 50% of DPPH is reduced. A low IC 50 value indicates a potent antioxidant activity. Ascorbic acid showed the inhibition concentration of IC 50 to be 9 ?gml -1 . The extract showed a similar antioxidant properties compared to the synthetic antioxidant (ascorbic acid). The seed extract of A. cinerea In vitro galvinoxyl Free Radical and Antioxidant Potential Galvinoxyl is a stable phenoxy radical that exhibits characteristic UV absorption at 429 nm in methanol solution. The radical have strong absorption in the visible region, while its absorption decreases proportionally upon receiving an electron or hydrogen from the antioxidants. The free radical scavenging potential of the phytochemicals in seed extract was (Lu et al., 2010). The result of galvinoxyl radical scavenging assay of the seed extract of A. cinerea grown in Nigeria is shown in Table 2. The extract was evaluated at the concentrations

of 1000, 500, 250, 125 and 100 ?gml -1 and with percentage free radical scavenging of 47, 42, 46, 20 and 19%, respectively. The seed exhibited the low inhibition concentration (IC 50) of 100.0 ?gml -1 and antioxidant activity index (AAI) of 0.4. The seed extract of A. cinerea investigated in this study had a lower galvinoxyl free radical scavenging and antioxidant compared to ascorbic acid (the reference compound), which had IC 50 and AAI values of 15.0 ?gml -1 and 2.8. The seed extract of A. cinerea investigated in this study gave a promising free radical scavenging and antioxidant activity comparable with the rhizome methanolic extract of Curcuma longa from Nigeria with galvinoxyl IC 50 and AAI values of 25 ?gml -1 and 1.68, respectively (Ololade et al., 2020). Generally, the extract investigated showed good antioxidant potential even at very low concentrations. Percentage radical scavenging activity was very low in galvinoxyl assay compared to DPPH assay. The results showed that the steric hindrance among adjacent bulky groups within a galvinoxyl molecule limited the extract to scavenge galvinoxyl radicals effectively unlike DPPH, while extracts showed a powerful capacity for scavenging free radicals in DPPH **??**Barzegar and

17 c) Antibacterial Potential

The antimicrobial potential of the seed extract of A. cinerea investigated in this study were tested against eleven clinically isolated multi-drug resistant Gramnegative (seven isolates) and Gram-positive (four isolates) strains of bacteria were investigated using the agar well diffusion method. The extracts investigated in this study demonstrated a broad-spectrum of activities against both Gram-positive and Gram-negative bacteria tested in this study. Table 3 and figure 1 summarize the zones of microbial growth inhibition and antibacterial index by the seed extract of A. cinerea, which showed good antibacterial activities against all the clinically isolated organisms. The result of the antimicrobial activity showed that the seed extract have high bactericidal activities from sensitive to ultra-sensitive as compared to cefuroxime (CRX) the synthetic antibiotic used in this study. Based on the value of zone of inhibition, the antibacterial activity potential was dependent on the concentrations of the extract used. Among the tested bacteria, the extract had a zone of inhibition of 30 mm on P. mirabilis which indicated that P. mirabilis was highly susceptible compared to the other tested bacteria within the concentration of 1000 ?gml -1 of seed extract of methanol/ethyl acetate of A. cinerea in this study. As depicted in Table 3, other high susceptible bacteria at 1000 ?gml -1 were Bacillus sp (25 mm), P. stuartii (25 mm), S. typhimurium (25 mm), E. faecalis (20 mm), S. marcescens (20 mm). At the concentration of 500 ?gml -1 of the seed extract, the bacteria inhibition activities were very high in S. typhimurium (25 mm), Bacillus sp (22 mm), E. faecalis (20 mm), P. mirabilis (20 mm), P. stuartii (20 mm). The zone of inhibition of the extract at the concentration of 250 ?gml -1 was significantly different when compared to 1000 and 500 ?gml-1 of the extract for the tested bacteria. At a lower concentration of 250 ?gml -1 of the extract, E. faecalis (20 mm) and P. mirabilis (20 mm) were more susceptible to the synergic activities of the secondary metabolites in the seed extract, most especially the phenolic compound and the terpenoids. The antibacterial index (AI) ranged between 0.5-25. Comparatively, the antibacterial properties of the extracts investigated in this study have similar antibacterial activities comparable to the leaf essential oil of A. cherimola from Egypt which was investigated for its in vitro antimicrobial properties against P. aeruginosa, S. aureus, B. subtilis, B. cereus with the zones of inhibition of 30, 26, 28 and 35 mm, respectively at 50 ?l (Mohammed et al., 2016). The differences in the zones of inhibition of the extract could be due to the difference in the levels of their major and minor phytochemical in the seed extract evaluated in this study and the synergetic effect between all the components. The differences in the susceptibility of the tested microorganisms to the extract may also be attributed to IV.

18 Conclusions

This study provides insight into the phytochemical, antioxidant and antimicrobial potential of the seed extract of A. cinerea. The study showed that the phytochemicals present in the extract have potential to be used to treat reactive oxygen species (ROS) induced and bacteria health related diseases by inhibiting the free radicals initiating associated with health problems. Further studies into the isolation and identification of phytochemicals that are responsible for the therapeutic potential and their in vivo mechanisms of action are necessary for the better understanding of their ability to control diseases that have a significant impact on quality of life. The present finding would be useful for future research directions on the application of the seed from A. cinerea in the development of safe drug and preservative for human and animals. [1]

[1]Compositional Analysis, Antioxidant and Antimicrobial Potential of the Seed Extract of Annona cinerea Dunal Grown in Nigeria

Figure 1:

results than antimicrobials from combinatorial chemistry and other synthetic procedures (Rossiter et al., 2017; Armas et al., 2019;
M
Medicinal plants have been used globally to meet health care needs of human and animals. Recently, medicinal plants have witnessed a glut of research geared towards validating the quality, quantity, protective roles as well as therapeutic effectiveness of

Figure 2:

Figure 3:

1

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19

[Note: C© 2020 Global Journals]

Figure 4: Table 1 :

2

Dunal Grown in Nigeria

Figure 5: Table 2 :

			AI		
25					25
20	17			19	20
	0.63	0.7	2.14	1.6	0.5

Figure 2: AI of the Extract against the Bacteria Isolates

Figure 6: 22

3

Organisms	ZI of the Seed Extract Conc. (µgml -1)	1000	500	250	Crx 30 µg
Bacillus sp (+)		25	22	19	-
E . faecalis(+)		20	20	20	-
K.pneumoniae(-)		17	17	17	-
M.varians (+)		19	14	14	30
P. aeruginosa(-)		17	13	13	25
P. mirabilis (-)		30	20	20	14
P. stuartii(-)		25	20	15	16
S. agalactiae(+)		19	19	19	-
S. dysenteriae(-)		10	10	10	20
S.marcescens (-)		20	14	-	-
S. typhimurium(-)		25	25	18	-

Figure 7: Table 3 :

Figure 8:

.1 Conflict of Interest Statement:

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of research reported.

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