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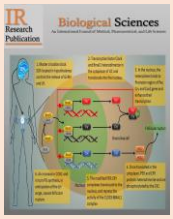

Phytochemical and antibacterial activity of *Khaya senegalinesis* Leaves Extracts with different solvent

N. Muhammad*, R.S. Saidu, B. Abdullahi, C.C Odenigboh, Zayyanu Iyya

School of Science Laboratory Technology Chemistry, Federal Polytechnic, Kaura-Namoda, Nigeria

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ABSTRACT

Phytochemical content as the main source of new antibiotics due to the presence of phytochemicals. The objectives of the research are to evaluate the phytochemical and antibacterial activity of *Khaya senegalensis* leaf extracts. Against different solvents and were subjected to phytochemical and antibacterial tests using Agar well diffusion method. Methanol extracts of all plant extracts Saponins are present only but absent in K. senegalensis from methanol extract. In addition, alkaloids are present in all crude methanol extracts. Steroids are found in K. *Senegalinesis*. Therefore, based on the pronounced activity of the extracts against the test bacteria, alkaloids, flavonoids and saponins were found to be 11.80 ± 0.02, followed by flavonoids from the extracts of acetate with a value of 10.33 ± 0.02, then they are also found in saponins. n-hexane extracts with a value of 9.6 ± 0.02, the minimum found in methanol respectively 1.77 ± 0.01. It can be suggested that this plant has potential as a source of therapeutic agents. Crude extracts showed different zones of inhibition against *Staphylococcus aureus*, Baccilus subtilis, with different concentrations, MIC was shown without turbidity. It is therefore suggested that more studies are carried out using different solvents and to isolate and identify the active ingredients present in the extracts to support these claims

*Address for correspondence
School of Science Laboratory Technology Chemistry, Federal Polytechnic, Kaura-Namoda, Nigeria
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Introduction

Medicinal plants act as an indigenous source of new compounds possessing therapeutic value and can also be used in drug development. Eighty percent of the population of developing countries depend on Traditional Medicines, mostly natural plant products, for their primary health care needs as estimated by WHO (1). Recognition of natural products for medicinal plants has higher demand that is increasing all over the world. Natural medicinal plants have minimal toxicity, are cost effective and pharmacologically active, and provide an easy remedy for many human ailments as compared to the synthetic drugs, which are a subject of adulteration and side effects, (2). Reported by (3) that the *Khaya senegalinesis*,

phytochemical screening shoe that Saponins, tannins alkaloids glycosides steroid and flavonoids are presents in the leaves and bark of the plants. The antimicrobial activity test against *Staphylococcus aureus*, *Staphylococcus feacalis* and *Candida albican* were susceptible to both leaves and bark extracts, were *Escherichia Coli* was not, the result of MIC and MBC show that the extracts of Khaya have bactericidal properties against *Staphylococcus aureus* shows the MIC of 7.81mg/mL while the Escherichia Coli did not show activity. Similar report by (4) show that the leaf of *Khaya senegalinesis* show the presence of Phytoconstituents such as Saponins flavonoids alkaloids and tannins against bacterial isolates Escherichia coli and salmonella typhi but statically there is no significance difference among the test organism with P-value =1>0.05, the MIC on ethanolic stem bark rangs from 12.5gm/mL but the ethanolic leaves extracts ranges from 25gm/L where E. coli and shegella are more sensitives at 25gm/mL Reported by (5) that the *Khaya senegalensis* has medicinal properties for the effective management of several ailments including diarrhea. To establish the pharmacological rationale for its traditional use, the powdered root, stem-bark and leaves were extracted with water and ethanol. All fractions were subjected to phytochemical screening and antimicrobial activity against gram-positive and gram-negative bacteria using the disc-diffusion method. The extracts contained saponins, tannins, phenols but no flavanoids, glycosides and resin. The stem-bark of the water fractions and the roots, stem-bark and leaves fractions of the ethanol fractions were active on *Staphylococcus aureus*, *Streptococcus spp*., *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella spp*. and *Baccilus subtilis*, these findings support the claim for its treatment of bacterial infection. Reported a Minimal Inhibitory Concentration (MIC) of 50 mg/ml for K. senegalensis extract on E. coli. The medicinal plant thus has a potential to be valorized in the fight against the diarrheic infections. Several studies have also reported bacterial growth inhibitory properties for K. senegalensis extracts. Both leaf and bark extracts inhibited the growth of the gram-positive bacteria *Staphylococcus aureus* and Streptococcus faecalis but were ineffective against the gram-negative bacteria, Escherichia coli. However, the MIC values reported in that study (4000-8000µg/mL) are indicative of only low to moderate growth inhibitory activity.(3) A different study reported antibacterial activity against a broader bacterial panel, although that study only tested a single extract concentration and did not report MIC values, making it impossible to compare the efficacy with other studies (5). Leaf and bar extracts inhibited the growth of Gram-positive bacteria *Staphylococcus aureus* and Streptococcus faecalis, but were ineffective against Gram-negative bacteria Escherichia coli. However, the MIC values reported in this study (4000–8000 µg/mL) are only indicative of weak to moderate growth inhibitory activity. Another study reported antibacterial activity against a wider spectrum. The increasing resistance to antibiotics has resulted in research towards the formation of new organic molecules from plants with antibacterial properties for the treating of diseases owing largely to disease resistance microorganism strains. There is the need to find an alternative approach in the treatment of infectious diseases. Using local plants will be a welcome development since the cost would be minimal. The leave extracts of *Khaya senegalensis* have been reported in the treatment of various ailments such as ulcer, dysentery diarrhea and some other health conditions, it is therefore important to scientifically investigate these plant parts to ascertain their therapeutic potentials (6).

Khaya senegalinesis is a medicinal herb considered efficient for the cure of various ailments. In Nigeria the *Khaya senegalinesis* is known traditionally for curing and treating diseases such as diarrhea, dysentery, intermittent fevers, typhoid fever, ulcers, wounds and diseases of the urino-genital system. This study has become necessary to find out if only the extracts of *Khaya senegalinesis* can effectively cure different ailments and also find out the best extract of the plants against the bacterial specimens. For quick scientific verification and documentation of these medicinal plants.

Materials and methods

The samples collection and identification

Fresh leaves of *Khaya senegalensis* were collected from the forests of Maru LGA, Zamfara State, Nigeria. It was taken to the Herbarium Unit, Faculty of Pharmaceutical Sciences of Usmanu Danfodiyo University Sokoto, Nigeria for proper identification and authentication which the voucher no. is given for reference.

Sample preparation

The three plants samples collected were thoroughly washed and dried in shade for two weeks after drying, the samples were grounded and coarsely powdered using a sterilized electric blender. Representative samples were quantitatively 200 g taken from each sample and homogenized using mortar and pestle. The homogenized sample for each was stored in an air tight plastic container for feature use.

Preparation of the culture media

The antibacterial activity was carried out using nutrient Agar which was prepared according to the manufacturer's recommendation. 14 g of nutrient

Agar was dissolved in 500 cm3 of distilled water. The nutrient agar prepared was distributed in 18 cm3 portioned each and was sterilized in an autoclave at 121oC for 15 minutes. The seeded Agar plates were prepared by pouring 18 cm3 of the molten nutrient Agar into sterile petri-dish which 0.1 cm3 of the test microorganism was added (7).

Preparation of stock solution of the extract

The preparation of stock solution was carried out by using 2 g of each extract which was carefully weighed and transferred into the sterilized test-tube. 2 cm3 DMSO was added to each of the test-tube containing the extract and was dissolved completely to get the stock (7).

Preparation of extracts (Maceration)

Exactly, 150 grams of powdered leaves of *Khaya senegalensis* were macerated individually in separate tanks with 500 cm3 n-Hexane, 500 cm3 of ethyl acetate and 500 cm3 methanol respectively, based on their increased polarity, which were allowed to stand for four (4) days with frequent agitation, the marc and the filtrate were separated using Whatman filter paper No 2, the filtrate/crude extract from each solvent were dried under reducing pressure and temperature in rotary vacuum evaporator. Then the nine extracts were dried for calculating the percentage of yield present in each extract. Finally, consistency and appearance of each extract were noted. Later individual extracts were collected and stored for further phytochemical and antibacterial studies (8).

The residue is weighed and the percentage yield is calculated using the equation below-

$$\frac{weight\ of\ the\ sample\ in\ powdered\ form\ in\ gram}{weight\ of\ the\ extracts\ in\ gram} \times 100 = \%\ yield$$

Qualitative phytochemicals (wet) test

The preliminary phytochemical screening was carried out using the standard specific protocols for the detection of bioactive chemical constituent such as tannins, saponin, flavonoids, alkaloids, terpenoids, cardiac glycosides, and steroids. The prepared plant extracts of all the 9 crude extracts of the plants were used to test for various phytoconstituents present using standard qualitative methods as described based (7).

Tests for alkaloid

Mayer's test: To the 2 cm^3 of the leaves extract, 2 cm^3 of conc. HCl was added. Then a few drops of Mayer's reagent were added. Formation of green color or white precipitate indicates the presence of alkaloids in the extracts (7).

Test for (Dragendoff's reagents)

Exactly, 1 cm^3 of aqueous extracts was stirred and placed in 1 % aqueous hydrochloric acid on a steam bath then, 1 cm^3 of the filtrates was treated with Dragendoffs reagent. Precipitation with is reagents consider the evidence of alkaloids (7).

Tests for cardiac glycoside

To the 2 cm^3 of various extracts a few drops of dilute Hydrochloric acid, 2 cm^3 Sodium Nitropruside in pyridine and Sodium Hydroxide solution were added in the test tube. Formation of pink to blood red color indicates the presence of Cardiac glycosides in the extracts (7).

Test for flavonoids Shinodas test

Shinoda's Test: The extracts were first dissolved in alcohol solution, and then portion of magnesium was mixed along with conc. HCl which was added dropwise. Formation of Magenta color indicates the presence of flavonoids in the extracts (7).

Test for saponins

To the 2 cm^3 of various extracts, 2 cm^3 of distilled water was added and mixed well for 15 minutes by shaking lengthwise in a graduated cylinder. Formation of 1cm layer of foam indicates the presence of saponins in the extracts (7).

Tests for tannins/polyphonols

To the 1 cm^3 of the various extract, 2 cm^3 of 5% ferric chloride was added in the tubes. Formation of greenish black or dark blue in the tube indicates the presence of tannins in the extract, (7). The 0.25 g of various extract was dissolved in 10 cm3 distilled water and then filtered. Further 1% aqueous Ferric chloride ($FeCl_3$) solution was added. Formation of intense green, purple, blue or black in the tube indicates the presence of tannins in the extracts (7).

Test for terpenoids

Salkowski Test: 5 cm^3 of various solvent extract was mixed in 2 cm3 of chloroform and 3 cm^3 concentrated H_2SO_4 was added. A layer of the reddish-brown color was formed at the interface of the tube that indicates the presence of terpenoids in the extracts (7).

Test for steroids

To the 1 cm^3 of the various extracts, 1 cm^3 of chloroform and few drops of conc. H_2SO_4 were added. Formation of brown ring indicates the presence of steroids in the extracts (7).

Quantitative phytochemical evaluation

Determination of total flavonoid

The plant extracts were (5 g) weighted and placed in 250 cm^3 conical flask, 100 cm^3 of dilute HCl acid was added and boiled in a water bath for 35 min, and filtered while stil hot to recover the extracts. The filtrate was treated with ethyl acetate in drop wise twice. The precipitate recovered was filtrated and weighed to give the percentage of the flavonoids presents (10).

$$\% \text{ Flavonoids} = \frac{W3-W1}{W2} \times 100$$

Where:
W1 is the weight of the empty filter paper
W2 is the weight of the extract = (5 g) for each sample
W3 is the weight of empty filter paper + the flavonoids precipitate

Determination of total alkaloids

Exactly 5 g of the sample was added into a 250 cm^3 beaker, then, 200 cm^3 of 10% acetic acid in ethanol were added and covered with aluminum foil and allowed to stand for 4 hours. The extract was filtered and concentrated on a water bath to a one-quarter of its original volume, a drop wise of concentrated ammonium hydroxide was added to the extract until a precipitation was formed. The precipitates were collected and wash with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed (10).

$$\% \text{ Alkaloids} = \frac{W3-W1}{W2} \times 100$$

Where:
W1 is the weight of the empty filter paper
W2 is the weight of the extract = (5 g) for each sample
W3 is the weight of empty filter paper + the alkaloids precipitate

Determination of total saponins

Exactly 5 g of dried fine powdered sample was put in to a conical flask, 25 cm^3 of 20% aqueous ethanol was added. The mixture was heated (55˚C) on water bath for 4 hours with continuous stirring. The mixture was then filtered and the residue re-extracted with another 100 cm^3 of 20% ethanol. This extract was further reduced to 20 cm^3 over hot water bath (90˚C). The concentrated extract was transferred into a 250 cm^3 separating funnel and 10 cm3 of diethyl ether was added and shaken vigorously. Ether layer was discarded while aqueous layer was collected. This step of purification was repeated with 30 cm3 of n-Butanol and extracts was washed twice with 5 cm3 of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation the samples were dried in the oven and weighed (11).

$$\% \; saponins = \frac{W3-W1}{W2} \times 100$$

Where:
W1 is the weight of the empty filter paper
W2 is the weight of the extract = (5 g) for each sample
W3 is the weight of empty filter paper + the Saponins precipitate

Antibacterial evaluation

Microorganism collection

The chemical isolates were collected from the stock organisms from the Department of Pharmaceutical Medical Microbiology, Usmanu Danfodiyo University, Sokoto. The microorganism used are Escherichia coli, *Staphylococcus aureus*, Pseudomonas aeruginosa and Bacilius subtitis which are both gram positive and negative bacteria.

Agar well diffusion method

The antimicrobial activity was determined using well diffusion method according to National Committee for Clinical Laboratory Standards (7). Petri plates containing 20 cm3 of, nutrient (for bacteria) agar medium were seeded with 1-2 day cultures of microbial inoculums (standardized inoculums 1.2 X 107 cfu/mL). Wells (4 mm in diameter) were cut off into agar and 50 µl of plant extracts were tested in a concentration of 5 mg/mL and incubated at 37oC for 24 hours. The antimicrobial activity was determined by measurement of the inhibition zone formed around the well.

Determination of minimum inhibitory concentration (MIC)

Minimum inhibitory concentration was determined using dilution method. The nutrient broth was prepared according to the manufacturer's instruction and 5 mL of the nutrient broth was dispensed into separate test-tube well labeled according the concentrations; 40 mg/mL, 20 mg/mL, 10 mg/mL, 5 mg/mL, 2.5 mg/mL, 1.25 mg/mL, 0.625 mg/mL, 0.156 mg/mL and 0.078 mg/mL then 0.2g of the extract was transferred into the test-tube of different concentration containing the normal saline from these concentrations, 4 cm3 of each stock solution was transferred to its corresponding test-tube serially. It was allowed to stand for 30 minutes before incubation (12).

After incubation, the lowest concentration which showed no turbidity in the test-tube was recorded as the MIC. The extracts the microorganisms served as control. Two control tubes were maintained for each test batch as follows: tubes containing extracts and the growth medium without inoculums (antibiotic control) and the tubes containing the growth medium, physiological saline and the inoculums (organism control). MIC was determined as the lowest concentration of the extracts permitting no visible growth (no turbidity) when compared with the control tubes. (13)

Statistical analysis

The results were expressed as mean ± standard errors of the mean (SEM) for all values. The quantitative estimation of secondary metabolite was statistically analyzed using one-way ANOVA followed by turkey pair wise comparison, Results were considered to be significant when P values are less than alpha 0.05 ($p<0.05$). Minitab®17.1.0 and Microsoft excel software were used to carry out the pre-treatment of date and statistical analysis.

Results and discussion

From the result of the extraction using the different of varying polarity it shows that methanol has higher polarity with 8.81% then, ethyl acetate with 7.96%the least is found in the n-Hexane extracts with 4.23% as showed in the table 1.

Table 2 the crude K. senegalensis Methanol Extract indicates, the presence of alkaloids, and saponins while cardiac glycoside, steroids, tannins, flavonoids and terpenoids are absents. Equally, K. senegalensis Ethyl acetate extracts indicate the presence of steroids, tannins and alkaloids. while cardiac glycosides, saponins and flavonoids are not detected from the extracts. The K. senegalensis n-Hexane extract indicates the presence of alkaloids and saponins while cardiac glycoside flavonoids, steroids, terpenoids and tannins are absents. These have agreements with finding (5).

The methanol extracts of all the plants contains Saponins, was only in *Khaya senegalensis* Also, alkaloids were present in all extracts of plants. As reported by (4). It clearly shows that the plants possess the active secondary metabolites which are responsible for antibacterial activity (14).

The existing literature suggests that phytochemicals documented for their antimicrobial potential belong to the major sub classes phenols, flavones, quinones, flavonols, terpenoids, coumarins, tannins, essential oils, polyamines, glycosides, alkaloids and many more (8, and 15). Although many classes of phytochemicals have been reported having antimicrobial abilities yet they have not been recognized as therapeutic agents by the medical communal (15).

Traditional practitioners made the use of water as a solvent but studies reported proved that methanol extracts were undoubtedly much better and hence more powerful. This is recognized due to the better solubility of the plant active metabolites in organic solvents (17). These clarifications can be rationalized by the escalating polarity of the compounds extracted by different solvents and their intrinsic bioactivity.

Our present study revealed good antibacterial effect of plant extracts towards a panel of microorganisms under study. This may be due to the rich diversity of phytochemicals such as flavonoids, Saponins, alkaloids, phenols and tannins present in the plant extracts.

Table 3 the Results of quantitative evaluation, the plants Methanol extracts show varying Saponin content, K. Senegalensis exhibits higher content of 11.80±0.02, (18) reports K. senegalensis having highest saponin content among many plants screened. The Alkaloid content of the extracts shows that K. senegalensis showed the least content of 1.77±0.01mg/g. Furthermore, Flavonoid content of K. senegalensis with 6.93±0.02 mg/g as reported by (19). Table 3 Ethyl acetate extracts of the plants tested indicates varying flavonoids contents, *Khaya senegalensis* showed highest with 10.33±0.01mg/g,

Moreover, Table 3 n-Hexane extract of plants revealed higher saponins content in *Khaya senegalensis* with 9.61±0.03 mg/g. Also, the alkaloids content determined from the plants revealed that Azadirachta indica has highest content with 4.09±0.02 followed by *Khaya senegalensis* with 2.21±0.01mg/g Generally, the plant extracts

Table 1. Percentage yield of extraction of Ficus sycomorus, Khaya senegalensis and Azadirachta indica.

S/No.	Plants	Extracts	Percentage Yield (%w/w)
1.	*Khaya Senegalensis*	Methanol extract	8.81
2.	*Khaya senegalensis*	Ethyl acetate extract	7.96
3	*Khaya senegalensis*	n-Hexane extract	4.23

Table 2. Preliminary Phytochemical Screening of Khaya senegalensis Plant Extracts using different solvents.

	Metabolites Tested						
Plant solvents	Alkaloids	Cardiac Glycoside	Flavonoid	Saponins	Steroids	Tannins	Terpenoids
K. senegalensis Hexane	+	-	++	+++	-	+	-
K. senegalensis Ethyl acetate	+	+	+++	++	-	+	-
K. senegalensis Methanol	+	-	++	+++	+	+	+

Key: +++ high, ++ moderate, + low

Table 3. Quantitative evaluation of the secondary metabolites.

S/N	Plants	Solvents	Alkaloid mg/g	Flavonoids mg/g	Saponins mg/g
1.	*Khaya senegalensis*	Methanol	1.77 ± 0.01^{d}	6.93 ± 0.02^{c}	11.80 ± 0.02^{a}
2.	*Khaya senegalensis*	Ethyl acetate	4.02 ± 0.01^{b}	10.33 ± 0.01^{a}	3.49 ± 0.02^{f}
3.	*Khaya senegalensis*	n-Hexane	2.21 ± 0.01^{c}	4.35 ± 0.01^{d}	9.61 ± 0.02^{b}

NB: means with the same superscript along the column are not significantly difference at $p\leq0.05$ represented in Mean ±SE.

Table 4. Average means of zones of inhibition of Khaya senegalensis plant leaves extract on the test organism.

Plants extract	Solvents	Ps (mm)	Bs (mm)	Ec (mm)	Sa (mm)
Khaya senegalensis	Ethyl acetate	7.75 ± 2.90^{d}	11.00 ± 3.03^{a}	8.25 ± 3.82^{c}	7.50 ± 3.86^{g}
Khaya senegalensis	n-Hexane	0.00 ± 0.00^{e}	4.25 ± 1.05^{e}	8.00 ± 3.34^{c}	10.50 ± 2.72^{c}
Khaya senegalensis	Methanol	11.00 ± 2.42^{b}	8.75 ± 3.42^{c}	5.75 ± 3.79^{e}	5.50 ± 3.20^{d}

NB: Means with the same superscript along the column are not significantly different at $p\leq0.05$. Key= Ps= *Pseudomonas aeruginosa*, Bs =*Baccilus subtilis*, Ec *Escherichia coli*, and Sa =*Staphylococcus aureus*.

Table 5. Minimum Inhibitory Concentration (MIC) of Khaya senegalensis.

Plants	Solvents	Organism	40 mg/ml	20 mg/ml	10 mg/ml	5 mg/ml	2.5 mg/ml	1.25 mg/ml	0.63 mg/ml	0.31 mg/ml	0.16 mg/ml
Khaya senegalensis	Methanol	Sa	-	-	+	+	+	+	+	+	+
Khaya senegalensis	Ethyl acetate	Bs	-	-	-	-	-	+	+	+	+

Key: Ps= *Pseudomonas aeruginosa*, Bs =*Baccilus subtilis*, Ec = *Escherichia coli*, and Sa= *Staphylococcus aureus*.

Table 6. Minimum Bactericidal Concentration (MBC) of Bioactive recorded Khaya senegalensis leaves extract against the bacterial isolates

Conc.	Solvents	Organism	40 mg/ml	20 mg/ml	10 mg/ml	5 mg/ml	2.5 mg/ml	1.3 mg/ml	0.63 mg/ml	0.31 mg/ml	0.16 mg/ml
K. *senegalensis*	Methanol	Sa	-	-	+	+	+	+	+	+	+
K. *senegalensis*	Ethyl acetate	Bs	-	-	-	-	-	+	+	+	+

Key: Ps= *Pseudomonas aeruginosa*, Bs =*Baccilus subtilis*, Ec= *Escherichia coli*, and Sa= *Staphylococcus aureus*.

equally, like the gram-positive bacteria can be accredited to its total phenolic content, which when higher can act as broad-spectrum antibacterial agent whereas when lower then shows almost no antibacterial activity (20). Moreover, it can be said that foods rich in polyphenols may significantly reduce the risk of various health problems due to their anti-mutagenic, ant-inflammatory, antioxidant, and antibacterial properties (21). It can be said that high content of Saponins present in plant extracts studied in this research could be considered as the basis for its antimicrobial property as claimed previously that Saponins rich plants have profound antimicrobial activity.

From Table 4, 5, and 6 indicates the antibacterial assay of the medicinal plants against the four bacterial isolates gram positive and gram-negative bacteria, the evaluation of the antibacterial activity of the compounds was determined by measuring the diameter of the zone of inhibition around the wells. The objective of this work was to determine among the compounds prepared those which had the greatest inhibitory activity of Gram-positive bacteria, Gram negative bacteria.

The results obtained revealed a notable antibacterial activity of the compounds of *Khaya senegalensis* Methanol extract *Khaya senegalensis* Ethyl acetate extract *Khaya senegalensis* n-Hexane extract *Khaya senegalensis* Methanol extract show similar activity against Ps and Bs and Ps respectively. *Khaya senegalensis* n-Hexane extract with 0.00±0.00 mm. The result obtained is almost similar the literature reviewed (22) reported the activity of the crude methanol extracts of Ficus sycomorus L. from stem-bark and leaves were examined in vitro against nine bacteria isolates pathogens to estimate the inhibitory effect of F. sycomorus L. Susceptibility and minimum inhibitory concentration (MICs) was inspected against four bacteria.

The lowest inhibitory concentration of the plant is measured against the bacterial isolate that shows the highest activity during the zone of inhibition determination, it is a comparatives study so I selected best among the three plants and from the result methanol and ethyl acetate show promising result so the Table 5. The MIC of the extracts was determined by diluting the various concentrations (40, 20, 10, 5, 2.5, 1.25, 0.62, 0.313, 0.156 and 0.078 mg/ml) of leaves respectively. Equal volume of the extracts and nutrient broth were mixed in the test tube. Specifically, 0.1 cm^3 of standardized inoculums of 1-2 X 107cfu/mL were added to each tube. The tubes were incubated aerobically at 37℃ for 18-24 hours. Two control tubes were maintained for each test batch as follows: tubes containing extracts and the growth medium without inoculums (normal saline) and the tubes containing the growth medium, physiological saline and the inoculums (organism control). MIC was determined as the lowest concentration of the extracts permitting no visible growth (no turbidity) when compared with the control tubes. *Khaya senegalensis* methanol extract shows the MIC at the concentration of 20 mg/mL in tube 2 against *Staphylococcus aureus* while *Khaya senegalensis* Ethyl acetate Extract show MIC at concentration of 2.5 mg/mL tube no. 5 against Bacillus subtilis, From the different result obtained in this experiment of MIC of *Khaya senegalensis Khaya senegalensis* Methanol Extracts against Pseudomonas aeruginosa at the concentration of 5 mg/ml.

Determination of minimum bactericidal concentration (MBC) was determined by sub-culturing the test dilution on fresh solid medium and further incubating at 37oC for 18-24 hours. The minimum bactericidal concentration (MBC) tubes with no visible bacterial growth on solid medium was regarded as MBC. From the Table 6 the minimum bacterial concentration of the various extract of the plants against different bacteria indicates that azadirachta methanol Extract show MBC at tube no 2 at concentration of 20mg/mL, *Khaya senegalensis* methanol extracts show MBC at tube No. 5 at the concentration of 2.5 mg/ml against bacterial isolates *Staphylococcus aureus* and *Khaya senegalensis* ethyl acetate show similar result at tube No. 5 at concentration of 2.5mg/ml against Bacillus subtilis. Ficus sycomorus Methanol Extract against show MBC at 20 mg/mL tube No. 2 against Ec,

Conclusion

In the present study, we conclude that flavonoids are a chemical class most often correlated with antimicrobial efficacy of herbal extracts. Our study showed *Khaya senegalensis* ethyl extracts contain the highest flavonoids contents in addition to highest Flavonoids contents, which is in accordance with the findings of (19) who reported the methanol extract to have maximum phenolic and Flavonoid levels, and displaying more pronounced antibacterial potential compared to other solvent extracted samples. From the statistical data obtain from ANOVA it indicates that there is no significant difference between the three solvent of extraction with the P-value (0.00). Therefore, we recommend that further research need to be conducted on the plant extracts to determine the structure of the metabolites that is responsible for the antibacterial activity of the three extracts.

Contribution of authors

N, Muhammad: funding acquisition, formal analysis, writing original draft, review & editing. M. Lawal: funding acquisition, formal analysis, writing original draft, review & editing. S.R. Saidu: conceptualization, formal analysis, writing original draft, writing review & editing. Zayyanu I. and Abubakar I: conceptualization, formal analysis, writing original draft, review & editing.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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