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Antimicrobial Activity and Phytochemistry of *Khaya senegalensis* Roots

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Crude extracts of Khaya senegalensis (Desr.) A. Juss roots were investigated for antimicrobial activity and were found to inhibit the growth of Pseudomonas aeruginosa, Staphyloccoccus aureus, Bacillus subtilis, Escherichia coli and Candida albican, but did not inhibit the growth of Peniciliium notatum and Aspergillus niger. The minimum inhibitory concentration (MIC) ranged from 6.0 mg/ml to 14.0 mg/ml, while the minimum bactericidal concentrations (MBC) ranged from 8.0 mg/ml to 20.0 mg/ml. When the extracts were compared with standard antibiotics (control), gentimycin (GN) and ciprofloxacin (CPX), it was observed that the control had a higher antimicrobial activity than the samples at the concentrations used. Preliminary phytochemical analysis of the root extracts showed the presence of alkaloids, tannins, saponins, phylates and oxalates. The quantitative phytochemical analysis showed a high quantity of tannins (7.12mg/100mg), phylate (4.75mg/100mg) and alkaloid (3.36mg/100mg). The proximate nutritive values also showed a high presence of potassium (52.57mg/kg), sodium (34.54mg/kg), calcium (18.43mg/kg) and magnesium (24mg/kg). Other elements observed were zinc (12.86mg/kg), iron (7.95mg/kg), manganese (5.79mg/kg), lead (2.03mg/kg) and chromium (1.42mg/kg). The sensitivity of these organisms to K. senegalensis root extract is an indication that it can be potentially useful for the treatment of their pathologies.

Keywords: Antimicrobial, phytochemistry, *Khaya senegalensis*, roots

Introduction

Several published reports have shown the effectiveness of traditional herbs against microorganisms (Ghani *et al*., 1989; Baker *et al*., 1995; Iwu *et al*., 1999; Shajahan and Ramesh, 2004; Obafemi *et al*., 2006). Medicinal plants contain physiologically active principles which over the years have been exploited in traditional medical practice for the treatment of various ailments (Adebanjo *et al*., 1985). As a result, plants are one of the bedrocks of modern medicine. The screening of plant extracts and natural products for antimicrobial activity has shown that higher plants represent a potential source of new, anti-infective agents, as well as serving drug discovery from natural products for primary lead compounds.

According to the World Health Organization (WHO, 2001), phytomedicines are herbal preparations, produced by subjecting plant materials to extraction, fractionation, purification, concentration, or other physical or biological processes which may be produced for immediate consumption, or as the basis for herbal products. The plant products may contain recipient or inert ingredients, in addition to the active ingredients. Phytomedicines can also be naturally-occurring substances, usually of plant origin, used in the prevention and treatment of diseases. Bringman and Pokorny (1995), posited that African plants constitute a rich untapped pool of natural products.

Khaya senegalensis, commonly known as African mahogany, is a species of plant in the *Meliaceae* family. It is found in many African countries including Nigeria, being native to tropical Africa (Wikipedia). It is an important multipurpose tree in its natural range within sub-Saharan Africa, being particularly valued for timber, fuelwood and medicinal purposes (Anonymous, 2000). It has attracted world-wide attention for its high quality timber production (Kubmarawa *et al*., 2008).

The bitter-tasting bark is highly valued in traditional medicine (Ijeoma *et al*., 1997). Bark decoctions or macerations are widely taken against fever caused by malaria and against stomach complaints, diarrhoea, dysentery and anaemia (Kubmarawa *et al*., 2008). In Cameroon, the bark is in demand as an additive in local beer brewing. Roots are applied against jaundice, stomach-ache, oedema and amenorrhoea. The roots and/or bark are an ingredient of complex arrow poisons of which *Strophanthus* roots or seeds are the main ingredients. Young twigs and roots are used as chewing sticks and toothbrushes.

K. senegalensis plants and some other plants are used in many African countries by traditional medicinal practitioners for the treatment of various ailments including bacterial diseases (Umeh, *et al*., 2005). It is a plant commonly used by the local people in Nigeria for the treatment of dysentery, mucous diarrhoea and wound infections (Ali *et al*., 2011).

The current research efforts are aimed at screening the antimicrobial activities of *Khaya senegalensis* root extracts for the possibility of enhancing their uses in medicine against pathogenic microorganisms.

Materials And Methods

Sample Collection

The roots of *Khaya senegalensis* were collected from Adamawa State, Northern Nigeria, and identified in the Herbarium in the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City. Samples of the roots were cut into small pieces with a clean scapel and air-dried under room temperature. They were later ground into fine powder using laboratory mortar and pestle in the Department of Pharmacognosy, Faculty of Pharmacy, University of Benin, Benin City. The powdered samples were stored in clean, dry, air-tight bottles and kept in a cool, dry place until required for use.

Extraction Procedure

The extraction was done using two solvents; distilled water and 95% ethanol. The extracts were prepared by weighing 100g each of the powdered root samples into 100ml distilled water and 100ml 95% ethanol in 250ml beakers separately. They were each stirred vigorously with a glass rod and the mixtures were allowed to settle for 24h, using the infusion method. Each extract was then filtered using Whatman No. 1 filter paper. The filtrates were later evaporated in a water bath, and the residues reserved as stock concentrates.

For the preparation of the different concentrations of the extract, 0.05g, 0.10g, 0.15g, 0.20g, 0.3g, 0.40g and 0.50g of the extracts were diluted in 100ml of distilled water to obtain concentrations of 5.0 mg/ml, 10.0 mg/ml, 15 mg/ml, 20 mg/ml, 30 mg/ml, 40 mg/ml and 50 mg/ml respectively.

Antimicrobial Activity Determination

The antibacterial and antifungal activities of the extracts were determined. The species of bacteria used for the study were *Bacillus subtilis*, *Pseudomonas aureginosa*, *Escherichia coli*, and *Staphylococcus aureus*, while the fungal species were *Candida albicans*, *Aspergillus niger*, and *Penicillium notatum*. Stock cultures of the microorganisms were maintained at 4^0C in Nutrient Agar for the bacteria species and Potato Dextrose Agar for the fungal isolates. The inoculums used were a broth of each microbial species grown for 24 h and diluted in distilled water. Serial dilutions with distilled water were made aseptically, using sterilized pipettes.

The activity testing was done using punch hole method of Stokes (1975). The plates were prepared by pouring nutrient agar media into sterile petri plates and allowed to set. The different organisms were flooded in the medium- a process called “seeding”. A 4 mm cork borer was used to punch holes in the medium. Three holes were made on each petri plate, adequately spaced out.

About 0.2ml of the different concentrations was delivered in each well. For bacteria, the petri plates were incubated at a temperature of 37^0C for 24 h, while for fungi, they were incubated at room temperature for 72 h, after which the zones of inhibition were measured by direct linear measurement using a metre rule.

Two standard antibiotics, Gentamycin and Ciproflxacin, were used for positive control.

Determination of Minimum Inhibitory Concentrations (MIC)

The extracts were incorporated into molten nutrient broth and Potato dextrose broth for bacteria and fungi respectively, at concentrations of 1.0mg/ml to 20.0mg/ml aseptically, mixed gently in the test tubes. The test tubes were inoculated with the appropriate bacteria and fungi culture, previously diluted to about 10^5cfu/ml. The test tubes were then incubated at 37^0C for 24 h for the nutrient broth, while the test tubes containing the Potato dextrose broth for the fungal isolates were incubated at 28^0C for 72 h. The lowest concentration preventing visible growth in each determination was taken as the minimum inhibitory concentration (MIC).

Determination of Minimum Bactericidal Concentration

This was an offshoot of the previously determined MIC. The least concentration of the plant extract in the test tube with no turbidity was taken as the minimum inhibitory concentration (MIC). Subsequently, those tubes that showed no turbidity were plated out on nutrient agar plates, and absence of growth on incubation for 24 h was confirmed as minimum bactericidal concentration (MBC).

Preliminary Quantitative Phytochemical Analysis of the Plant Extracts

Phytochemical analysis of the extracts was carried out according to the methods described below, for the detection of active components like saponins, tannins, alkaloids, glycosides and so on.

Test for Alkaloids

To 3 ml of the extract, 1ml of 1% hydrochloric acid (HCL) was added in a test tube. The mixture was heated for 20minutes, cooled and filtered. Two drops of Mayer’s reagent was added to 1ml of the extract. A creamy precipitate was an indication of the presence of alkaloids.

Test for Tannins

To 1 ml of the extract, 1ml of freshly prepared 10% Potassium hydroxide (KOH) was added. A dirty white precipitate showed the presence of tannins.

Test for Glycosides

To 1ml extract, 10 ml of 50% H_2SO_4 was added, and the mixture was heated in boiling water for about 15minutes. 10 ml of Fehling's solution was then added and the mixture was boiled. A brick-red precipitate confirmed the presence of glycosides.

Test for Saponins

Frothing Test: 2 ml of the extract was vigorously shaken in the test tube for 2 minutes.
The observation of frothing confirmed the presence of saponin.

Emulsion Test: 5 drops of olive oil was added to 3ml of the extract in the test tube and vigorously shaken. The presence of stable emulsion confirmed the presence of saponin.

Test for Flavonoids

To 3 ml of the extract, 1 ml of 10% NaOH was added. There was no yellow colouration which indicates the absence of flavonoids.

Test for Steroids

Five drops of concentrated H_2SO_4 was added to 1ml of extract in a test tube. Red colouration was observed, which indicated the presence of steroids.

Test for Triterpenes

5 drops of acetic anhydride and a drop of concentrated H_2SO_4 were added to 1ml of the extract. The mixture was then steamed for 1h and neutralized with NaOH, followed by the addition of chloroform. Absence of blue-green colour indicated the absence of triterpenes.

Test for Phylate

One gram of the extract was weighed, and 5 ml of diluted water was added and stirred with a magnetic stirrer for 1h, and 0.1ml of Ferric solution was added to the filtrate, and allowed to stand for 15 minutes. The formation of chelation indicated the presence of phylate.

Quantitative Phytochemical Analysis

Test for Tannin

The ethanol extract (1ml) was treated with 5ml of Folin Dennis reagent in a basic medium and allowed to stand for 30 minutes for colour development. The absorbance of the reaction mixture of each sample was measured at 760 nm spectrophotometrically.

Test for Phylate

One gram of extract was measured in a 100 ml conical flask and immersed in 25 ml of 0.5 mol L^{-1} HNO_3 for 3 – 4 h under continuous shaking on a magnetic stirrer plate. The contents were transferred to a centrifuge tube, and were centrifuged at 4, 000 rpm for 10 minutes. 1ml 50µg/ml Ferric solution (Fe_3g, L^{-1} Titrisol, merck Ref. 099) was added, and the tube was vortexed. The test tube was left to stand for 15 minutes in order to allow chelation of iron molecules by indigenous plant phytates. The tubes were capped and boiled for 20 minutes. After boiling, the tubes were immersed in cold water. 75 ml of distilled water was added to each tube, then vortexed. 0.1ml of this solution was extracted and transferred to a 5-inch test tube. 9ml of distilled water was added, and the tube was vortexed. The contents of the tube were transferred to a curvette and read at 465 nm.

Test for Alkaloid

Harbone Method

A drop of concentrated ammonium hydroxide solution was added to the extract to precipitate the alkaloids. The precipitate was filtered off with a weighed filter paper, and washed with ammonium hydroxide solution. The precipitate in the filter paper was dried in the oven at 60^0C for 30 minutes, and reweighed.

Test for Total Oxalate

One gram of the extract was added to 7ml of H_2SO_4. The solution was carefully stirred intermittently with a magnetic stirrer for 1h, and filtered, using Whatman No. 1 filter paper. 25ml of the filtrate was then collected and treated against 0.1M $KMnO_4$ solution till a faint pink colour appeared that lasted for 30 seconds.

Test for Saponin

Ten grams of the extract was added to 20 ml of 20% aqueous ethanol and agitated with a magnetic stirrer for 12 h at 55^0C. The solution was then filtered using Whatman No. 1 filter paper, and the residue was re-extracted with 200 ml 20% aqueous ethanol. The extract was reduced to 40 ml under vacuum and 20 ml diethylether was added in a separating funnel and shaken vigorously. The aqueous layer was recovered and the ether layer was discarded. The pH of the aqueous solution was adjusted to 4.5 by adding NaOH. The solution was shaken with 60 ml n-butanol. The combined butanol extracts were washed twice with 10 ml of 5% aqueous NaCl and evaporated to dryness in a fume cupboard to give a crude saponin which was weighed.

Test for Glycosides

Two grams of the sample was mixed with 30 ml of distilled water, and heated for 15minutes on a water bath, and filtered. 5 ml of the filtrate was added to 0.2 ml of Fehling solution A and B until it turned alkaline, and the mixture was heated in a water bath for 2 minutes. A light-blue colouration was observed (instead of the brick-red precipitate), which indicates the presence of glycosides (Oloyede, 2005).

Test for Flavonoid

Five hundred mg of the powdered root was extracted in 10 ml acetone (80%) using mortar and pestle. The homogenate was filtered using Whatman No. 1 filter paper. The reaction mixture contained 1.5 ml of the plant extract, and 1.5 ml of 2% methanoic aluminium chloride. The absorption of the reaction mixture was measured at 367.5 nm on a UV visible spectrophotometer. Total flavonoid content was calculated, with the help of the standard curve, and the values were expressed.

Statistical Analysis

Results were expressed as Mean ± Standard Error of Mean (S. E. M.) and the level of significance between the means was computed by the t-test, using SPSS 10.0 computer software package. The level of significance was determined at 0.5.

Results

Crude Extracts

The antimicrobial activity of the crude root extracts revealed that the ethanol extract had a higher antibacterial and antifungal activity than the aqueous extract. One of the fungi was sensitive to the ethanol crude extract (Table 1).

Table 1: Antimicrobial activity of crude *Khaya senegalensis* root extracts

Test Isolates	Ethanol Extracts (mm)	Aqueous Extracts (mm)
Pseudomonas aeruginosa	20.0	13.0
Staphylococcus aureus	18.0	9.0
Bacillus subtilis	16.0	10.0
Escherichia coli	14.0	16.0
Candida albicans	10.0	0.0
Penicillium notatum	0.0	0.0
Aspergillus niger	0.0	0.0

Antimicrobial Activities of the Aqueous Root Extracts at different Concentrations:

Table 2 shows that *Pseudomonas aeruginosa* had the highest zone of inhibition throughout the concentrations tested, except 5 mg/ml. No zone of inhibition was found in 5 mg/ml.

Table 2: Antimicrobial activity of *Khaya senegalensis* aqueous root extract at different concentrations.

	Concentration (mg/ml)				Control	
Test Isolates	5	10	15	20	GN	CPX
Pseudomonas aeruginosa	0.00±0.00	5.00±0.58	10.00±0.58	13.33±0.58	14.00	15.00
Staphylococcus aureus	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	10.00	20.00
Bacillus subtilis	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	20.00	22.00
Escherichia coli	0.00±0.00	0.00±0.00	7.00±0.58	10.00±0.58	11.00	10.00
Candida albicans	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-
Penicillium notatum	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-
Aspergillus niger	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-

n= 3; values are mean ±; SEM; GN=Gentamycin; CPX = Ciprofloxacin; - = not tested.

Antimicrobial Activities of the Ethanol Root Extracts at different Concentrations: With the ethanol root extracts, the highest zone of inhibition was also found in *Pseudomonas aeruginosa*. The fungi isolates did not show any sensitivity on the ethanol root extracts at concentrations of up to 20mg/ml (Table 3).

Table 3: Antimicrobial activity of Khaya senegalensis ethanol root extract at different concs.

	Concentration (mg/ml)				Control	
Test Isolates	5	10	15	20	GN	CPX
Pseudomonas aeruginosa	0.00±0.00	5.00±0.58	10.00±0.58	12.00±0.58	14.00	15.00
Staphylococcus aureus	0.00±0.00	0.00±0.00	3.00±0.58	9.00±0.58	10.00	20.00
Bacillus subtilis	0.00±0.00	2.33±0.33	6.33±3.33	10.67±0.33	20.00	22.00

Escherichia coli	0.00±0.00	8.00±0.58	7.00±0.58	10.00±0.58	11.00	10.00
Candida albicans	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-
Penicillium notatum	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-
Aspergillus niger	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	-	-

n= 3; values are mean±SEM; GN=Gentamycin; CPX = Ciprofloxacin; - = not tested.

Minimum Inhibitory Concentration

Table 4 reveals the minimum inhibitory concentration of the root extracts of *Khaya senegalensis*. The ethanolic and aqueous extracts on *Staphyloccoccus aureus* and *Escherichia coli* had similar MIC of 14.0 mg/kg respectively.

Table 4: Minimum Inhibitory Concentration (MIC) of *Khaya senegalensis*

Test Isolates	**Ethanol Extract (mg/ml)**	**Aqueous Extract (mg/ml)**
Pseudomonas aeruginosa	6.0	8.0
Staphylococcus aureus	14.0	0.0
Bacillus subtilis	13.0	0.0
Escherichia coli	8.0	14.0
Candida albicans	0.0	0.0
Penicillium notatum	0.0	0.0
Aspergillus niger	0.0	0.0

Minimum Bactericidal and Fungicidal Concentration:

Table 5 shows the minimum bactericidal and fungicidal concentration of *Khaya senegalensis* root extracts.

Table 5: Minimum Bactericidal and Fungicidal Concentrations of *Khaya senegalensis* root extracts

Test Isolates	**Ethanol Extract (mg/ml)**	**Aqueous Extract (mg/ml)**
Pseudomonas aeruginosa	8.0	20.0
Staphylococcus aureus	10.0	0.0
Bacillus subtilis	15.0	0.0
Escherichia coli	10.0	15.0
Candida albicans	0.0	0.0
Penicillium notatum	0.0	0.0
Aspergillus niger	0.0	0.0

Phytochemical Analysis

The preliminary quantitative phytochemical analysis of *Khaya senegalensis* root extracts is shown on table 6.

Table 6: Preliminary Quantitative phytochemical analysis of *Khaya senegalensis* root extracts

Parameters	Root Extract
Alkaloids	+
Tannins	+
Flavonoids	-
Saponins	+
Glycosides	-
Phytates	+
Oxalates	+

Key

+ = Present

- = Absent

Quantitative Phytochemical Analysis

Table 7 shows the quantitative phytochemical analysis of *Khaya senegalensis* root extract

Table 7: Quantitative phytochemical analysis (mg/100) of *Khaya senegalensis* root extracts

Parameters	Root Extract
Oxalates	2.07
Phytates	4.75
Saponin	1.69

Alkaloid	3.36
Glycoside	-
Flavonoid	-
Tannin	7.12

Proximate Nutritive Values

Table 8 shows the proximate nutritive values (mg/kg) of *Khaya senegalensis* root extracts

Table 8: Proximate Nutritive Values (mg/kg) of *Khaya senegalensis* root extracts

Parameters	Extract
Potassium	52.57
Sodium	34.54
Calcium	18.43
Magnesium	24.84
Zinc	12.86
Iron	7.95
Manganese	5.79
Lead	2.03
Chromium	1.42

Discussion

The crude extracts of *Khaya senegalensis* root showed inhibitory activities against all the bacterial and one fungal test organisms that were used (Table 1). It was observed that susceptibility increased with the increased concentration of the extracts for the bacterial isolates (Tables 2 and 3). The fungal isolates recorded resistance for the concentrations of the root extracts used (Table 2 and 3).

In general, the ethanol extracts were observed to be more potent and consistent in activity than the aqueous extract. The ethanol extract recorded the highest inhibitory effect of 12.00 mm at 20 mg/ml (Table 3). These results confirm earlier studies that observed that plant extracts in organic solvents provided more consistent antimicrobial activity, compared to those extracted in water (Parekh *et al*., 2005; Ahmad *et al*., 1998).

The most sensitive test organism was *P. aeruginosa* which had an inhibitory diameter of 20.0 mm at the crude antimicrobial sensitivity. This was followed by *S.aureus*, B.subtilis and *E. coli* with inhibition diameter zones of 18.0 mm, 16.0 mm and 14.0 mm respectively (Table 1). In the sensitivity test carried out by Abalaka *et al*.(2011), it was reported that *S.aureus* and *E.coli* were sensitive to extracts of *K.senegalensis* in an increasing order. They also confirmed that the ethanol extracts showed more sensitivity than the aqueous extracts.

One of the fungal organisms, *Candida albicans*, showed antimicrobial sensitivity when the extract was used in the crude state (Table 1), but when it was used in concentrations of up to 20 mg/ml, there was no sign of sensitivity in any of the fungal isolates. This infers that very large quantities of the root samples of *K.senegalensis* would be needed for the antimicrobial sensitivity of fungi.

All the extracts recorded no activity against any of the organisms at 5 mg/ml. However, the inhibitory effects were observed in an ascending order across the other concentrations of 10 mg/ml, 15 mg/ml 20 mg/ml, 30 mg/ml and 40 mg/ml. The inhibitory effects of the extracts corroborate an earlier report by Makut *et al* (2007) that the ethanol extracts of *K.senegalensis* has antimicrobial activities on *S.aureus* and *C.albicans*. The activity of the ethanol extracts against the three test fungi was not significantly different from that of the aqueous extract.

When the extracts were compared with the control (standard sensitivity test), it was observed that the control had a higher antimicrobial activity than the samples (Tables 2 and 3).

The results of the phytochemical screening of the root extracts (Table 6), revealed the presence of alkaloids, tannis, saponins, phytates and oxalates. Flavonoids and glycosides were observed to be absent. Kubmarawa *et al.* (2008), confirmed the presence of saponins and tannins and the absence of glycosides and flavonoids in *khaya senegalensis* plants.

The quantitative analysis of the extract showed that the root extract, had a high quantity of phytate (4.75mg/100g). Phytic acid is the principal store of phosphate and it is a natural plant oxidant. Phytic acid showed a protective action in carcinogenesis. This action can be explained by its mineral chelating potential. Phytic acid may have health benefits for diabetic patients. It reduces blood glucose response, by reducing the rate of starch digestion. Phytic acid also releases inositol during digestion, which might reduce depression. It also reduces inflammation.

The results also showed that the root extract had a very high quantity of tannin (7.12mg/100g). Tannin has anti-bacterial, anti-enzymatic and astringent properties (Machado *et al*., 2002; Scalbert, 1991). The ingestion of tannin can

be used to treat diarrhoea (in the absence of fever or inflammation). The anti-oxidant and anti-mutagenic properties of tannic acid are beneficial. Externally, tannins can be used to treat ulcers, tooth aches and wounds (Roger, 2004).

The results also showed high presence of alkaloid (13.36mg/100g). Alkaloid comes from a class of naturally occurring organic nitrogen-containing bases. The medicinal properties of alkaloids are quite diverse. Morphine is a powerful narcotic used for the relief of pain. Codein is an excellent analgesic that is relatively non-additive. Certain alkaloids act as cardiac or respiratory stimulants. Many alkaloids possess local anaesthetic properties. Quinine is a powerful anti-malarial agent. Two alkaloids, Vincristine and Vinblastine (from *Vinca rosea*) are widely used as chemotherapeutic agents in the treatment of many types of cancer.

The results also showed that the root extracts had some quantity of oxalate (2.07mg/100g). Oxalates provide essential nutrients, fibre, antioxidants and other important phytochemicals. Oxalic acid is a naturally-occurring component of plants, and is found in relatively high levels in dark-green, leafy foods.

Macro and micro elements like potassium, sodium, calcium, magnesium, zinc, iron, manganese, lead and chromium were found in the root extract (Table 8).

Potassium was recorded to be very abundant in the root extract. Potassium is the third most abundant mineral in the body, and it is considered an electrolyte. It helps regulate blood pressure and heart functioning. Research shows that increasing potassium intake can reduce blood pressure.

Sodium was found to be next in abundance to potassium in the root extract (Table 8). The main purpose of sodium is to dissolve waste minerals. Sodium present in salt regulates the amount of fluid that the body contains, eliminates fluid waste through urine, and maintains fluid balance.

Magnesium was also found in large quantities in the root extract. Magnesium is needed for the body to function correctly. It is necessary for the correct assimilation of potassium and the efficient functioning of enzymes. DNA and RNA synthesis, cell growth and cell reproduction are regulated by magnesium. It also orchestrates the electric current that sparks through the miles of nerves in the body.

The phytochemical analysis carried out on the root extract was in agreement with an earlier work by Makut *et al*., (2007) on the phytochemical screening of ethanolic and methanolic extracts of the leaves and bark of *K. Senegalensis.*

The combination of K. *senegalensis* with some other herbs and therapies can make treatment more effective. This combination, and all other herbal treatments, should only be done with the advice and consultation of a qualified healthcare practitioner.

Conclusion

The ethanolic and aqueous extracts of the root of *K. Senegalensis* showed activity against all the test bacteria (gram positive and gram negative) used in this study. This implies that *K. Senegalensis* possesses antibacterial properties. It is therefore recommended as a potential antimicrobial agent.

The result from this study also provides evidence that the aqueous and ethanol extracts of the root of *K. Senegalensis* contains some phytochemicals that are essential in pharmaceutical, medical and food industries. The presence of secondary metabolites might be responsible for the plant's medicinal properties. However, further studies are recommended on the chemical characterization of the extracts.

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