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Research Paper

Antibacterial activity of the leaf and stem bark crude extracts of *Khaya senegalensis*

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Abstract. The antibacterial activity of the aqueous and ethanolic leaf and stem bark crude extracts of *Khaya senegalensis* against four bacteria species (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus pneumonia* and *Escherichia coli*) was investigated using the agar well diffusion technique. At concentrations ranging from 400 to 1000 mg/ml the ethanol crude extracts showed activity against the four bacteria species, with mean zone of inhibition ranging from 7.67 ± 0.33^{a} to 19.66 ± 0.33^{b}. Similarly the aqueous crude extract at 400 to 1000 mg/ml recorded low activity with mean zone of inhibition ranging from 0.33 ± 0.33^{a} to 13.3 ± 0.33^{c}. Minimum inhibitory concentrations of the crude extracts were 200 and 400 mg/ml and the minimum bactericidal concentration was also 400 and 800 mg/ml. The lethal dose (LD_{50}) of the crude extracts of *K. senegalensis* was found to be greater than 5000 mg/kg. The phytochemical components of the crude extracts include alkaloid, steroids, glycosides, tannins, saponins and flavonoids. The study revealed that the plant could be a potential source of antibacterial agent.

Keyword: Antibacterial, concentration, extract, Inhibition, *Khaya senegalensis*.

INTRODUCTION

Phytomedicines are herbal preparations produced by subjecting plant materials to extraction, fractionation, purification, concentration, either through physical or biological processes which may be produced for immediate consumption (WHO, 2001). The plant products may contain recipient or inert ingredients, in addition to the active ingredients (Silva et al., 1996). Phytomedicines can also be naturally-occurring substances, usually of plant origin, used in the prevention and treatment of diseases (Fatope et al., 2001). The medicinal flora in the tropical region has a preponderance of plants that provide raw materials for addressing a range of medical disorders and pharmaceutical requirements (Fatope et al., 2001).

Khaya senegalensis belong to maliceae family (Umeh et al., 2005). The plant is also known as the African dry zone mahogany, reaches height of 130 to 165 ft and a trunk diameter of 5 ft above the ground. The trunk bole is straight, with branches generally occurring approximately 33 ft of the ground. The thick bark is reddish-brown and coarse in texture. The pinnate leaf generally possesses four to seven pairs of leaflets that measure about 3 to 5.5 inches long. The flowers appear whitish with pyramid shape at the end of branchlets (Ijeoma et al., 1997). The woody fruit is shaped similar to a capsule with five sections, or valves. These valves contain the winged seeds that measure about an inch in diameter. *K. senegalensis* has been found to contain anthracitic derivers and steroids, which makes it a better antidiabetic agent (Takin et al., 2014).

In West Africa, Fulani herdsmen used the stem-bark and leaf of *K. senegalensis* for the treatment of diarrhea, syphilis, pyrexia and malarial fever (Olayinka et al., 1992; Ali et al., 2011). Similarly in Northern Nigeria, the Hausas utilize *K. senegalensis* extracts as a remedy for several human and animal ailments (Deeniand and Sadiq, 2002;

Wurochekke and Nok, 2004).

MATERIALS AND METHODS

Collection and identification of plant materials

Fresh sample of the plant was collected from Maryam Babangida Girls Secondary School Minna, Niger State. The plant materials were identified in the Biological Sciences Department, Federal University of Technology, Minna (voucher reference number 487MBG).

Preparation of the extracts

The plant parts were thoroughly washed and air dried and ground to powder. One hundred gram (100 g) of each ground part (that is, leaf and stem bark) was mixed with 500 ml of distilled water and 500 ml of (95%) ethanol in each case were allowed to stand for 72 h. The mixtures were filtered and the filtrate collected separately in a clean beaker. The extracts were evaporated, using steam bath to dryness. The dry extracts were weighed and kept in sterile sample bottles and stored in the refrigerator at 4°C for further use.

Phytochemical screening

The phytochemical screening of the crude extracts was carried out for possible detection of some secondary metabolites such as alkaloids, tannins, saponin, flavonoid, glycosides, steroids and phlobatannins. The method of Harborne (1992) and Trease and Evans (1989) were employed.

Test organisms

The test organisms used were clinical isolates obtained from the Laboratory Department of General Hospital, Minna, Niger State. The organisms include *Staphylococcus aureus, Streptococcus pneumoniae, Escherichia coli,* and *Pseudomonas aeruginosa.* The isolates were identified using the schemes of Cheesbrough (2006) and then sub-cultured into nutrient agar slants for further use.

Standardization of test organisms

The McFarland standard of 0.5 was employed in standardizing the test organisms. The four bacterial isolates were transferred aseptically from agar plate cultures into test tubes containing 5 ml of nutrient broth. The inoculated broth was incubated at 37°C for 6 h (Andrews, 2005). The turbidity of the actively growing culture was adjusted with sterile saline or broth to obtain turbidity that is optically comparable to that of the 0.5 McFarland standards (Collins et al., 1995; Andrews, 2005).

Antimicrobial assay of the extracts

The antimicrobial activity assay was done using the method described by Idu and Igeleke (2012). The plates were prepared by pouring nutrient agar media into sterile petri plates and allowed to set. Each organism (culture) was inoculated on three (3) plates (replicate) using swab stick. A 4 mm cork borer was used to bore holes on the medium, and the bottom of each hole was sealed with a drop of molten agar to avoid seepage of the extract. Four holes were made on each petri plate, adequately spaced out. About 0.2 ml of the different concentrations (400, 600, 800 and 1000 mg/ml) were introduced into the well. The petri plates were incubated at 37°C for 24 h, after which the zones of inhibition were measured using a meter rule. A standard antibiotic, ampiclox was used as positive control. One inoculated plate served as organism viability control, an uninoculated plate served as media sterility control and another uninoculated plate containing the extract served as extract sterility control (Idu and Igeleke, 2012).

Minimum inhibitory concentration (MIC)

The MIC of the crude extracts was determined by broth dilution method. Test tubes were labeled and 5 ml of nutrient broth was introduced into each test tube, 0.5 ml of bacteria suspension (1.0×10^6) was inoculated. This was followed by the addition of different concentrations (100, 200 400, 800 and 1600 mg/ml) of the extract to the sterile nutrient broth test tubes. In the control tubes, the crude extracts were not added (Andrews, 2001). The uninoculated test tubes were used to check the sterility of the medium and as negative control while the positive control tubes were used to check the suitability of the medium for growth of the microorganisms and the viability of the inoculums. The final volumes in all the test tubes were adjusted to 10 ml using distilled water. The mixtures in all the test tubes were mixed properly before incubation at 37°C for 24 h. Observation for turbidity was carried out. The MIC was determined by the lowest concentration of the extract that prevented visible growth (Andrews, 2001).

Minimum bactericidal concentration (MBC)

The MBC of the extract(s) was determined by sub culturing the contents of the tubes that showed inhibition of growth onto extract-free medium. The tube(s) that showed no turbidity were plated out on nutrient agar plates which had neither antibiotics nor crude extract and

Table 1. Phytochemicals of the leaf and stem-bark of *Khaya senegalensis.*

Phytochemical component	SBaq	SBeth	Laq	Leth
Alkaloids	-	-	+	+
Flavonoids	+	+	-	+
Glycosides	+	+	-	+
Phlobatanins	-	-	-	-
Saponins	-	-	+	+
Steroids	+	+	+	+
Tannins	+	+	+	+

Key: SBaq: Aqueous Stem Bark Extracts, SBeth: Ethanol Stem Bark Extract Laq: Aqueous Leaf Extract, Leth: Ethanol Leaf Extract, + Present, - Absent.

incubated for 24 h (French, 2006).

Thin layer chromatography

Thin layer chromatography was performed on a sheet of glass which was coated with a thin layer of adsorbent material such as silica gel. This layer of adsorbent is known as the stationary phase.

The sample of the crude extracts were then applied at one end of the plate and placed in a beaker containing a shallow amount of the solvents, chloroform/ methanol (3:2). After the sample has been applied on the plate and placed in the beaker, the solvent was drawn up the plate via capillary action. The different analytes ascend the TLC plate at different rates and so separation is achieved. The solvent front reached no higher than the top of the plate in the chamber. The plate was removed (continuation of the elution would have given a misleading result) and dried (Abalaka et al., 2011). The result was then read using an ultra violet (UV) lamp.

Acute toxicity

The acute oral toxicity of the plant extracts was determined, using the technique described by Organization of Economic and Cooperative Development OECD guidelines (2000). The limit test was used at 5000 mg/kg. A group of 5 mice per extract was dosed and placed under observation for 24 h. The number of dead animals was recorded and the lethal dose (LD_{50}) was calculated using the formula below:

$LD_{50} \surd (D0 \times D100)$

Where D0 = Dosage of 0% mortality, D100 = Dosage of 100% mortality

The animals were observed closely for 4 h, 24 h and 14 days for any delayed toxic shock signs such as: general activity, irritability, response to touch, grasping the tail, twisting, strength of grip, tremors, convulsions, stimulation, respiratory frequency etc. The number of death was recorded (Gaya et al., 2008).

RESULTS

Phytochemical analysis of *Khaya senegalensis*

The phytochemical analysis of *K. senegalensis* revealed the presence of steroids, tannins, flavonoids, glycosides, saponins and alkaloids. Steroids and tannins were present in all parts of the plant. Flavonoids and glycosides were present in all parts with the exception of the aqueous leaf extract. Saponins and alkaloids were only present in the leaf extracts of both solvents.

The mean zone of inhibition of aqueous stem bark crude extract (SBaq) at concentrations such as 400, 600, 800 and 1000 mg/ml on four bacteria isolates. The effect of the crude extracts on *S. aureus* was 0.00 ± 0.00^{a} for all the concentrations of the crude extracts and 20.50 ± 0.29^{b} for the Control. The mean values for the zone of inhibition on *P. aeruginosa* were 6.33 ± 0.33^{a}, 8.67 ± 0.33^{b}, 9.00 ± 0.58^{b} and 11.0 ± 0.58^{c} respectively for all the concentrations. The mean zones of inhibition on *S. pneumoniae* were 10.5 ± 0.29^{a}, 11.67 ± 0.33^{b} and 12.16 ± 0.17^{b}, 13.3 ± 0.33^{c} respectively for all the concentrations. The mean zones of inhibition on *E. coli* were 4.50 ± 0.29^{a}, 10.67 ± 0.33^{b}, 10.83 ± 0.44^{b} and 12.0 ± 0.00^{c} respectively for all the concentrations (Table 2).

The mean zone of inhibition of ethanol stem bark crude extract (SBeth) at concentrations such as 400, 600, 800 and 1000 mg/ml on four bacteria isolates. The effect of the crude extracts on *S. aureus* was 7.83 ± 0.44^{a}, $8.33 \pm 0.33^{a, b}$, $9.33 \pm 0.33^{b, c}$ and 9.67 ± 0.33^{c} for all the concentrations of the crude extracts. The mean values for the zone of inhibition on *P. aeruginosa* were 13.67 ± 0.33^{a}, $15.67 \pm 0.88^{a,b}$, 16.33 ± 0.88^{b} and 17.33 ± 0.67^{b} respectively for all the concentrations. The mean zones of inhibition on *S. pneumoniae* were 18.0 ± 0.00^{a}, 18.33 ± 0.33^{a}, 19.33 ± 0.33^{b} and 19.66 ± 0.33^{b} respectively for all the concentrations. The mean zones of inhibition on *E. coli* were 13.67 ± 0.33^{a}, $14.0 \pm 0.58^{a,b}$, $14.67 \pm 0.33^{a,b}$ and 15.33 ± 0.67^{b} respectively for all the concentrations (Table 3).

Table 2. Mean zone of inhibition of aqueous stem bark crude extract (SBaq).

Conc. of the crude extracts (mg/ml)	Organisms			
	SA	PA	SP	EC
400	0.0 ± 0.00[a]	6.33 ± 0.33[a]	10.5 ± 0.29[a]	4.50 ± 0.29[a]
600	0.0 ± 0.00[a]	8.67 ± 0.33[b]	11.67 ± 0.33[b]	10.67 ± 0.33[b]
800	0.0 ± 0.00[a]	9.00 ± 0.58[b]	12.16 ± 0.17[b]	10.83 ± 0.44[b]
1000	0.0 ± 0.00[a]	11.0 ± 0.58[c]	13.3 ± 0.33[c]	12.0 ± 0.00[c]
Control (10 mg/ml)	20.50 ± 0.29[b]	24.83 ± 0.44[d]	22.33 ± 0.33[d]	20.67 ± 0.33[d]

*Results represent Mean ± Standard Error Mean of triplicate determinations. Results with the same superscript on the same column are not significantly different at p ≤ 0.05. Key: SA: *Staphylococcus aureus* PA: *Pseudomonas aeruginosa* SP: *Streptococcus pneumonia* EC: *Escherichia coli.*

Table 3. Mean zone of inhibition of ethanol stem bark crude extracts (SBeth).

Concentration of the crude extracts (mg/ml)	Organisms			
	SA	PA	SP	EC
400	7.83 ± 0.44[a]	13.67 ± 0.33[a]	18.0 ± 0.00[a]	13.67 ± 0.33[a]
600	8.33 ± 0.33[a,b]	15.67 ± 0.88[a,b]	18.33 ± 0.33[a]	14.0 ± 0.58[a,b]
800	9.33 ± 0.33[b,c]	16.33 ± 0.88[b]	19.33 ± 0.33[b]	14.67 ± 0.33[a,b]
1000	9.67 ± 0.33[c]	17.33 ± 0.67[b]	19.66 ± 0.33[b]	15.33 ± 0.67[b]
Control (10 mg/ml)	20.50 ± 0.29[d]	24.83 ± 0.44[c]	22.33 ± 0.33[c]	20.67 ± 0.33[c]

*Results represent Mean ± Standard Error Mean of triplicate determinations. Results with the same superscript on the same column are not significantly different at p ≤ 0.05. Key: SA: *Staphylococcus aureus*; PA: *Pseudomonas aeruginosa*; SP: *Streptococcus pneumonia*; EC: *Escherichia coli.*

Table 4. Mean zone of inhibition of aqueous leaf crude extract (Laq).

Concentration of the crude extracts (mg/ml)	Organisms			
	SA	PA	SP	EC
400	ND	0.33 ± 0.33[a]	7.33 ± 0.33[a]	1.67 ± 0.33[a]
600	0.33 ± 0.33[a]	1.67 ± 0.33[b]	8.00 ± 0.58[a,b]	2.0 ± 0.58[a]
800	2.67 ± 0.33[b]	2.33 ± 0.33[b]	8.67 ± 0.33[b]	2.67 ± 0.33[a,b]
1000	3.0 ± 0.0[b]	2.67 ± 0.33[b]	8.67 ± 0.33[b]	3.33 ± 0.33[b]
Control (10 mg/ml)	20.50 ± 0.29[c]	24.83 ± 0.44[c]	22.33 ± 0.33[c]	20.67 ± 0.33[c]

*Results represent Mean ± Standard Error Mean of triplicate determinations. Results with the same superscript on the same column are not significantly different at p ≤ 0.05. Key: SA: *Staphylococcus aureus*; PA: *Pseudomonas aeruginosa*; SP: *Streptococcus pneumoniae*; EC: *Escherichia coli.*

The mean zone of inhibition of aqueous leaf crude extract (Laq) at concentrations such as 400, 600, 800 and 1000 mg/ml on four bacteria isolates. The effect of the crude extracts on *S. aureus* was 0.33 ± 0.33[a], 2.67 ± 0.33[b] and 3.0 ± 0.0[b] respectively for all the concentrations. The mean values for the zone of inhibition on *P. aeruginosa* were 0.33 ± 0.33[a], 1.67 ± 0.33[b], 2.33 ± 0.33[b] and 2.67 ± 0.33[b] respectively for all the concentrations. The mean zones of inhibition on *Streptococcus pneumoniae* were 7.33 ± 0.33[a], 8.00 ± 0.58[a, b], 8.67 ± 0.33[b] and 8.67 ± 0.33[b] respectively for all the concentrations. The mean zones of inhibition on *E. coli* were 1.67 ± 0.33[a], 2.0 ± 0.58[a], 2.67 ± 0.33[a, b] and 3.33 ± 0.33[b] respectivelyfor all the concentrations (Table 4).

The mean zone of inhibition of ethanol leaf extract (Leth) was calculated at concentrations of 400, 600, 800 and 1000 mg/ml on four bacteria isolates. The effect of the crude extracts on *S. aureus* was 7.67 ± 0.33[a], 8.67 ± 0.33[a,b], 9.00 ± 0.58[b] and 9.33 ± 0.33[b] respectively for all the concentrations. The mean values for the zone of inhibition on *P. aeruginosa* were 10.33 ± 0.33[a], 10.33 ± 0.33[a], 11.00 ± 0.58[a] and 11.67 ± 0.67[a] respectively for all the concentrations. The mean zones of inhibition on *S. pneumoniae* were 11.3 ± 0.88[a], 11.33 ± 0.88[a], 12.33 ± 0.33[a], and 13.33 ± 0.33[a] respectively for all the concentrations. The mean zones of inhibition on *E. coli* were 11.33 ± 0.33[a], 11.67±0.33[a, b], 12.67 ± 0.33[b, c] and 13.67 ± 0.33[c] respectivelyfor all the concentrations (Table 5).

The minimum inhibitory concentration (MIC) of the

Table 5. Mean zone of inhibition of ethanol leaf crude extract (Leth).

Concentration of the crude extracts (mg/ml)	Organisms			
	SA	PA	SP	EC
400	7.83 ± 0.33[a]	10.33 ± 0.33[a]	1.3 ± 0.88[a]	11.33 ± 0.33[a]
600	8.33 ± 0.33[a,b]	15.67 ± 0.88[a,b]	18.33 ± 0.33[a]	14.0 ± 0.58[a,b]
800	9.33 ± 0.33[b,c]	16.33 ± 0.88[b]	19.33 ± 0.33[b]	14.67 ± 0.33[a,b]
1000	9.67 ± 0.33[c]	17.33 ± 0.67[b]	19.66 ± 0.33[b]	15.33 ± 0.67[b]
Control (10 mg/ml)	20.50 ± 0.29[d]	24.83 ± 0.44[c]	22.33 ± 0.33[c]	20.67 ± 0.33[c]

*Results represent Mean ± Standard Error Mean of triplicate determinations. Results with the same superscript on the same column are not significantly different at p ≤ 0.05. Key: SA: *Staphylococcus aureus*; PA: *Pseudomonas aeruginosa*; SP: *Streptococcus pneumoniae;* EC: *Escherichia coli.*

Table 6. Minimum inhibitory concentration (MIC) of the crude extracts of *Khaya senegalensis.*

Organism	SBaq (mg/ml)	SBeth (mg/ml)	Laq (mg/ml)	Leth (mg/ml)
SA		400	800	800
PA	400	200	400	200
SP	200	200	400	200
EC	400	200	400	200

Key: SA: *Staphylococcus aureus;* PA: *Pseudomonas aeruginosa;* SP: *Streptococcus pneumoniae;* EC: *Escherichia coli;* SBaq: Aqueous Stem Bark Extracts; SBeth: Ethanol Stem Bark Extract Laq: Aqueous Leaf Extract; Leth: Ethanol Leaf Extract.

Table 7. Minimum bactericidal concentration (MBC) of the crude extracts of *Khaya senegalensis.*

Organism	SBaq (mg/ml)	SBeth (mg/ml)	Laq (mg/ml)	Leth (mg/ml)
SA		800	1600	800
PA	800	400	800	400
SP	400	400	800	400
EC	800	400	800	400

Key: SA: *Staphylococcus aureus;* PA: *Pseudomonas aeruginosa;* SP: *Streptococcus pneumoniae;* EC: *Escherichia coli;* SBaq: Aqueous Stem Bark Extracts; SBeth: Ethanol Stem Bark Extract; Laq: Aqueous Leaf Extract; Leth: Ethanol Leaf Extract.

Table 8. Antibacterial activity of the TLC fractions.

Organisms	SBaq	SBeth	Laq	Leth
Staphylococcus aureus	-	-	-	-
Pseudomonas aeruginosa	-	-	-	-
Streptococcus pneumoniae	-	-	-	-
Escherichia coli	-	-	-	-

Key: SBaq: Aqueous Stem Bark Extracts, SBeth: Ethanol Stem Bark Extract Laq: Aqueous Leaf Extract, Leth: Ethanol Leaf Extract, - : No Growth

crude extracts of the leaf and stem bark of *K. senegalensis* ranged from 200 to 800 mg/ml (Table 6).

The minimum bactericidal concentration (MBC) of the crude extracts of the leaf and stem bark of *K. senegalensis* ranged from 800 to 1600 mg/ml (Table 7).

Table 8 shows the antibacterial activity of thin layer chromatography (TLC) fractions of *K. senegalensis*. The fractions had no activity on the organisms.

The oral acute toxicity test (LD_{50}) of the crude aqueous and ethanolic extract of the leaf and stem bark of *K. senegalensis* were carried out. There was no mortality in animals at a fixed dose of 5000 mg per kilogram body weight. The behavioral changes shown by the animals at 5000 mg/kg bw were increased drowsiness, ruffled fur

Table 9. Safe dose determination (LD_{50}) of the crude extracts of the leaf and stem bark.

Extracts	Number of mice	Conc. of extracts (mg/kgbw)	Number of death 0/5
SBaq	5	5000	0/5
SBeth	5	5000	0/5
Laq	5	5000	0/5
Leth	5	5000	0/5

Key: SBaq: Aqueous Stem Bark Extracts, SBeth: Ethanol Stem Bark Extract Laq: Aqueous Leaf Extract, Leth: Ethanol Leaf Extract

and reduced motility which disappeared within 24 h of administration of the extract (Table 9).

DISCUSSION

In this study, the antibacterial potentials of the aqueous and ethanolic extracts of *K. senegalensis* was investigated. The results revealed the presence of saponin, flavonoid, tannin, alkaloid, glycoside and steroid. Similar studies by Makut et al. (2007), Wakirwa et al. (2013) consistently reported phytochemical constituents of *K. senegalensis* to be alkaloids, tannins, saponins and flavonoids. Therefore the result of the phytochemical analysis of the crude extracts of *K. senegalensis* obtained in this study conforms to the previous reports.

The antibacterial effects of the crude extracts of *K. senegalensis* were determined in comparison with the standard antibiotic (ampliclox) against the test organisms. There was a significant difference between the zone of inhibition by the crude extracts and the antibiotic (control). The inhibitory effects of the crude extracts could be attributed to the phytochemical components of the crude extracts as reported in previous study by Kubmarawa et al. (2008).

The aqueous stem bark extract had no inhibitory effect on *S. aureus*. This could be as a result of the absence or low concentration of the active ingredients in the aqueous crude extract such as tannin, saponin etc. as a result of incomplete extraction of the secondary metabolites from the plant materials due to the method used for the extraction. This finding contradict the work of Kubmarawa et al. (2008) that reported inhibitory effect of aqueous stem bark of *K. senegalensis* on *S. aureus.*

The aqueous and ethanolic stem bark crude extracts and also the aqueous leaf crude extract (Laq) had higher activity on *S. pneumoniae* compared to other bacteria used in the study. The activity of the ethanol leaf crude extract on both *S. pneumoniae* and *E. coli* were not significantly different.

Generally the ethanol crude extracts had better activity than the aqueous crude extracts. This shows that ethanol is a better extracting solvent than water in this study. This is in line with the findings of Ahmad et al. (1998), Parekh et al. *(*2005) and Abalaka et al. (2011).

In all, the antibacterial activity of the crude extract of *K. senegalensis* was found to be more as the concentration of the extracts increases, which implies that the higher the concentration, the more the activity by the crude extracts on the organisms. This is also in line with the observations of Idu and Igeleke (2012).

The minimum inhibitory concentration (MIC) is the smallest concentration that visibly inhibits growth. The MIC is useful in determining the smallest effective dosage of a drug against bacteria (Prescott et al., 2002). The MIC result obtained from this study revealed that different concentrations of the crude extract served as the MIC values against the organisms. Some of the organisms (*P. aeruginosa*, *S. pneumoniae* and *E. coli*) were more sensitive to the crude extracts even at a low concentration; as a result they had low MIC value compared to *S. aureus* with a high MIC value.

The bacteria (*P. aeruginosa*, *S. pneumoniae* and *E. coli*) were more sensitive to the ethanol crude extracts with an MIC value of 200 mg/ml with the exception of *S. aureus* which had MIC value of 400 mg/ml. The MIC value of the aqueous crude extract of the same bacteria was 400 mg/ml with the exception of *S. aureus* which had an MIC value of 800 mg/ml; this is an indication of resistance. This is in line with the findings of Ahmad et al. (1998), Parekh et al. (2005) and Abalaka et al. (2011).

The results of the minimum bactericidal concentration (MBC) of the crude extracts yielded a higher MBC values ranging from 400 to 1600 mg/ml which implies that very high concentration of the extracts is required to exert a bacteriocidal effect on the organisms. This conforms to the work of Abalaka et al. (2011).

The lethal dose (LD_{50}) of the crude extracts of *K. senegalensis* was found to be greater than 5000 mg/kg. This result shows that *K. senegalensis* can be considered to be non-toxic. This is in line with the work carried out by Onu et al. (2013).

The fractions obtained from the thin layer chromatography of *K. senegalensis* had no antibacterial effect on the test organisms. This could be as a result of the low quantity of the active ingredients in the fractions obtained.

Conclusion

The result of the investigation indicated that the ethanol

and aqueous leaf and stem bark of *K. senegalensis* were effective on *S. aureus, P. aeruginosa, E. coli* and *S. pneumoniae.* The ethanol stem bark extract (SBeth) had higher activity on the bacteria species investigated. A high concentration of the plant is required to act on the bacteria. The plant is considered safe for consumption as a result of the acute toxicity test carried out on the plant. This is an indication that the plant could be a source of antibacterial agents.

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