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Full Length Research Paper

Antibacterial efficacy of stem bark extracts of *Mangifera indica* against some bacteria associated with respiratory tract infections

El-Mahmood Muhammad Abubakar

Department of Microbiology, School of Pure and Applied Sciences, Federal University of Technology, PMB 2086, Yola, Nigeria. E-mail: elmahmud.abubakar33@gmail.com. abusal2008@yahoo.com.

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Phytochemical screening of the crude stem bark extracts of *Mangifera indica* revealed the presence of alkaloids, phenols, tannins, saponins and cardiac glycosides. The antibacterial activity of the crude extracts were assayed using the agar well diffusion methods on clinical bacterial isolates of *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumonia* and *Streptococcus pneumonia* obtained from patients previously diagnosed with respiratory tract infections. At a concentration of 50 mg/ml, the crude extracts inhibited the growth of all the respiratory tract pathogens, though with varying degrees of susceptibility depending on the bacterium and the extracting solvent. The MIC values ranged from 12.5 - 200 mg/ml, while the MBC values ranged from 50 - 400 mg/ml and this is very important for people who depend on the plant for their health care needs. The presence of the bioactive compounds has been linked to the antimicrobial activity of the extracts. The activity of the crude drug was more under acidic conditions and at elevated temperatures. The results obtained in this study support the use of the plant in herbal medicine. The stem bark of the *M. indica* tree can be used as a source of broad spectrum oral antibiotic to fight respiratory tract pathogens.

Key words: Phytochemical screening, *Mangifera indica,* bioactive, herbal medicine, respiratory tract, pathogens.

INTRODUCTION

Respiratory tract infections continue to be the most frequent and important cause of short term illnesses that compel an individual to seek medical attention not only in the developing world, but also in the developed world. It is typically the first infection to occur after birth. Respiratory tract infections are caused by a handful of bacteria, fungi and viruses and account for more than 40% of disability days, secondary to acute illnesses, and pneumonia and influenza accounting to 80 - 90% of death in the elderly (Hugonnet et al., 2000). Among the pathogens, bacteria contribute substantially to illness and death. The most frequent bacteria includes *Escherichia coli, Pseudomonas aeruginosa, Moraxella catarrhalis Staphylococcus aureus, Stretococcus pneumoniae, Heamophilus influenza* and *Klebsiella pneumonia* which colonize the respiratory tract of young children and the elderly as commensals, and quite often results in diseases whenever the condition warrants (Melinda et al., 2008). These bacteria are known to have a number of virulent factors, some encoded in plasmids, bacteriophages and the bacterial chromosomes as well as their ability to colonize in a biofilm make the cells impervious to therapeutic concentrations of antibacterial agents (Brander et al., 2005; Lino and Degracious, 2006). Development of virulent factors among infectious agents varies, some bacteria can resist phagocytosis, for instance, *Streptococcus pneumoniae and Haemophilus influenza* produce a slippery mucoid capsule that pre-vents the phagocyte from effectively contacting the bacterium, while *Staphylococcus aureus* produces leukocidins that destroys phagocytes before phagocytosis and also produces coagulase which coagulates (clots) the fibrinogen in

plasma protecting the pathogen from phagocytosis and isolates it from other host defenses. *Pseudomonas aeruginosa* cleaves laminin associated with basement membranes. *E. coli* lyses erythrocytes and weakened host defenses. Adhensins are specialized molecules or structures on the bacterial cell surface that bind to complementary receptor sites on the host cell surface (Hugonnet et al., 2000; Lesch et al., 2001; Prescott et al., 2005).

Illiteracy, poverty, poor sanitation and hygienic practices expose a large proportion of people in the developing world to a wide array of microbial pathogens (Fennell et al., 2004). An estimated 2.2 million people die each year because of acute respiratory infections. The financial impact associated with respiratory tract infections is in excess of 20 billion dollars in direct treatment costs (Oteo et al., 2005) Respiratory tract infections affect the upper and lower respiratory tracts leading to severe diseases such as whooping cough, tuberculosis, pneumonia, bacterial pharyngitis/tonsillitis, asthma amongst others.

Higher plants are employed as medicine by different people of both rural and urban areas all over the world who have been using them as sources of food and medicines since the dawn of civilization (Sofowora, 1992). Medicinal properties of plants are hinged on the presence of bioactive principles such as alkaloids, phenols, tannins, glycosides and essential oils amongst others. This necessitates the need for continued screening of medicinal plants, not only to determine the scientific basis for their usage, but also to discover new active principles (Karou et al., 2006). The primary benefits of using plant-derived medicines are that they are relatively cheaper than synthetic alternatives, offering profound therapeutic benefits and more affordable treatments. Many of the plant materials used in traditional medicine are readily avalable in rural areas and this has made traditional system of medicine relatively cheaper than modern medicine. Many works have been done with the aim of knowing the different antimicrobial and phytochemical constituents of medicinal plants and using them for the treatment of microbial infections as possible alternatives to antibiotics and other chemotherapeutic agents to which many infectious microorganisms have become resistant. As a result, many potent drugs have been purified from plants, including emetin, quinine, ipecucuanha and artemisin and introduced to modern medical practice.

Mangifera indica belongs to the family Anacardiaceae which consists of about sixty genera and six hundred species, which are mainly tropical trees and shrubs. It is widely used as a source of food, medicines and timber and is known by its local names, the Yoruba and the Fulani called it *Mangoro,* Igbo called it *Mangolo,* Hausa called it *Mangwaro* and the Chamba people called it *Mangoron* (Bala, 2006). The mango is indigenous to eastern Asia, Myanmar (Burma), and Assam state of India. Cultivated in many tropical regions, mango has special significance in Africa, and a large part of Asia including Pakistan, India, Bangladesh and Philippines. Its leaves lare ritually used for floral decorations at Hindu marriages and religious ceremonies (Khan and Omotoso, 2003; Rao and Modi, 1976). In some of the islands of the Caribbean, the leaf decoction is taken as a remedy for diarrhea, hemorrhages and bleeding hemorrhoids, fever, chest complaints, diabetes, hypertension and other illnesses. The bark contains Mangiferine and is astringent and employed against rheumatism and diphtheria in India. The resinous gum from the trunk is applied on cracks in the skin of the feet to treat scabies. In Nigeria, *M. indica* are commonly used as herbal preparations in the treatment of tooth ache, gastrointestinal disorders, dysentery, diarrhea, gastrointestinal tract infections, respiratory and urinary tract infections, sore-gums and sore throats (Bala, 2006).

The leaves are long and leathery containing a chemical called *Mangiferine*, or “Indian yellow” which was used as a dye. The main constituent is citric acid, although glycollic, oxalic, malic aspartic acid, glutamic acid, alanine, glycerine, serine and amino butyric acid and tartaric acids are also present (Anjaneyulu et al., 1989, Bala, 2006). Among the compounds isolated from *M. indica* extract are terpenoidal saponins, polygalacturonase, fructose-1-6-diphosophatase, triterpenoid, 2-hyroxymangiferonic acid tetracyclic triterpenoid and pentacyclic triterpenoid (Khan et al., 1993). Since rural people generally stay at home and nursed their illnesses back to health using local herbs, it would be interesting to study the efficacy of the crude stem bark extracts of *M. indica* against some economically important bacteria that frequently cause respiratory tract and other infections in the developing world. The effects of pH and temperature on the activity of the extracts were also studied to see if the plant products can be formulated into oral preparations and marketed as such. Research into the antimicrobial activity of this plant is expected to enhance the use of the plant in the management of infectious diseases including respiretory tract infections.

MATERIALS AND METHODS

Collection of plant materials

Fresh bark of *M. indica* were collected from Ganye local government area of Adamawa State of Nigeria in the month of may, 2008 and were identified by Mr. Brimstone Bariri of Botany Department, Federal University of Technology, Yola.

Preparation of plant materials

The freshly collected stem barks were spread to dry under shade at normal room temperature for seven days in the shade. Upon drying, the plant materials were pounded using mortar and pestle into smaller particles and then blended to powder using Kenwood electric blender (Kenwood Ltd, Harvant, United Kingdom) and the powder stored in airtight containers and kept under normal room temperature (28 ± 2°C) until required.

Collection of test organisms

The test organisms were clinica l isolates obtained from patients

previously diagnosed with respiratory tract infection from the 750-bed Specialist Hospital, Yola. Sputum, throat and mouth specimens were collected with the aid of the hospital staff following standard procedures described by Cheesborough (2006). For sputum collection, patients were instructed to provide deep coughed specimens and each of the specimens was expelled into a sterile container. For collection of throat and mouth specimens, the handle of a spoon was used to depress the tongue to examine the mouth for the presence of inflamed membrane, exudates or pus. The mucous membrane of the mouth was rubbed with a sterile cotton wool swab taking enough care not to contaminate with saliva. Each of the swab samples was transported to the hospital laboratory in a container of Amies medium (Oxoid). Sputum and the swab samples were cultured on blood agar, Deoxycholate Citrate agar and MacConkey agar plates at 37°C for 24 h. Discrete colonies were isolated and cultured on Mueller Hinton agar slants and were immediately transported to the Microbiology laboratory of the Federal University of Technology, Yola and kept at 4 - 6°C for identification purposes. All the isolates were sub cultured thrice to obtain pure culture. The isolated colonies were subjected to gram staining and the colonies showed morphological and cultural characteristics of *S. aureus, E. coli, P. aeruginosa, S. pneumoniae* and *K. pneumonia.* All test bacteria were cultured and properly identified following standard methods described by Cowan and Steel (1974) and Cheesborough (2006). All the test bacteria were maintained in a refrigerator at 4°C on Mueller Hinton agar slants until required (El-Mahmood et al., 2008)

Phytochemical screening

Phytochemical screening was carried out to determine the presence of tannins, saponins, glycosides, carbohyradrates, phenols and cardiac glycosides (Harbourne, 1973, Baker and Thormsberg, 1983, Sahm and Washington, 1990). The solvents used were distilled water, ethanol and hexane.

Extraction procedure

10 g of powdered sample was soaked in 100 ml solvent contained in a 500 ml sterile conical flask. The flask was covered with cotton plug and then wrapped with aluminum foil and shaken vigorously at 3 h intervals for 48 h at room temperature. The crude extract was then filtered using muslin cloth and then Whatman no.1 filter paper. The filtrate was evaporated to dryness using rotary evaporator (Model 349/2, Corning Limited) maintained at 40°C and the dried substance was stored in airtight bottles until required. The yield was for water, 17.6%; ethanol 19.6% and hexane 14.9%. The percentage extract yield (w/w) was estimated as dry extract weight/dry material weight x 100 (Parekh and Chanda, 2007). For the preparation of dilutions of crude extracts for antibacterial assay, the extracts was reconstituted by redissolving in the respective extracting solvents and further diluted to obtain 200, 100, 50, 25, 12.5, 6.25, 3.085 and 1.03 mg/ml.

Antimicrobial susceptibility testing

The test bacteria were sub- cultured into a Mueller Hinton broth from agar plates and was incubated for 24 h at 37°C prior to each antimicrobial testing. The standardization of culture was done according to the method of National committee for clinical standard (1990), by suspending a bacterial culture into sterile universal bottle containing Mueller Hinton broth, normal saline was added gradually to it so as to compare the turbidity to that of 0.5 MacFarland Standard that corresponds to approximately 10^8 cells.

Agar diffusion method was used for antimicrobial susceptibility testing (El–Mahmood et al., 2008). 1 ml of test culture (10^8 cfu/ml) which corresponds to 0.5 McFarland Standard) was placed into a sterile plate and 19 ml molten agar at 45°C was poured and the plates were rocked several times for even spread and proper mixing of bacteria and the agar. The agar was allowed to solidify on a flat bench at room temperature. Five wells measuring 6 mm in diameter and 2.5 mm deep was made on the surface of the agar medium using a sterile 6 mm cork borer. The plates were turned upside down and the wells were labeled with a marker. Then 0.5 ml of the reconstituted extract at a concentration of 100 mg/ml was pipetted into the first, second and third hole, 0.5 ml of streptomycin (30 µg) solution into the forth hole to serve as a positive control, 0.5 ml of solvent into the fifth hole to serve as a negative control. The plates were allowed to stand on a flat bench for 30 min to allow for diffusion into agar before incubation at 37°C for 24 h. The experiment was done in triplicate and mean zone diameter taken with the help of a vernier caliper. The mean of three results was taken and interpreted appropriately.

Effect of pH on activity of extracts

The extract was reconstituted by dissolving 100 mg of the powdered plant material into 1 ml of solvent, mixed very well so as to obtain a concentration of 100 mg/ml in separate sterile test tubes. The first test tube was adjusted to pH 2 by adding 1N hydrochloric acid (HCL) dropwise until pH 2 was reached. The second test tube was adjusted to pH 10 by adding 1 M sodium hydroxide (NaOH) drop wise until pH 10 was reached as monitored by a pH meter. This acid /alkali treatment was done for a duration of 1 h, and then neutralized to pH 7 by adding either acid or alkali as the case may be. The third test tube was not treated with either acid or alkali and served as positive control, while a solution of pure solvent served as negative control. Then 1 ml bacterial culture suspension was added and their antibacterial activity was determined using agar well diffusion method as described earlier.

Effect of temperature on the activity of extract

The powdered plant material was reconstituted as described above in to three test tubes to obtain a concentration of 100 mg/ml in three separate test tubes. Thereafter 1 ml of the culture was added to each test tube. The first test tube was refrigerated to a temperature of 10°C and, the second test tube raised to a temperature of 100°C by placing on electro thermal hot plate(Model no. SK3588.350 C max Serial no. 10044037, Made in England) for 1 h. After treatment, the treated test tubes were left for another 1 h at room temperature to stabilize. The third test tube was left untreated at room temperature and served as positive control, while a solution of the pure solvent served as negative control. Then 0.5 ml of the contents of each test tube was introduced into the wells bored on the Mueller Hinton agar plate and was incubated at 37°C for 24 h and the zones of inhibition produced were measured and the mean zone diameter of triplicate results tabulated.

Determination of minimum inhibitory concentration (MIC)

The methods described by Emeruwa (1992) and El-Mahmood et al. (2008) were used. The MIC of the extracts was determined for each of the test bacteria in triplicates. 1ml of the concentrations of the extracts adjusted to a concentration of 400 mg/ml was added to 1 ml Mueller Hinton broth. Then 1ml was transferred from the first test tube to the next until the 7^{th} test tube was reached. Then 1 ml of the test bacteria previously adjusted to 1 x 10^8 cfu/ml added and the contents thoroughly mixed on a whirl mixer. A tube containing Mueller Hinton broth only was seeded with the test bacteria serves as a control. All the tubes were incubated at 37°C for 24 h, after which the tubes were observed for growth by visual inspection. The

same method was followed using standard antibiotic after incubation for 24 h at 37°C.The least concentration of the plant extract that did not permit any visible growth of the inoculated test organism in broth culture was taken as the MIC in each case (Banso, 2009).

Determination of minimum bactericidal concentration (MBC)

For each of the test tubes in the MIC determination which did not show any visible growth, 100 µl of broth was inoculated aseptically on a sterile Mueller Hinton agar surface by the streak plate method. The plates were then incubated for 48 h at 37°C. The lowest concentration of the plant extract that did not yield any colony growth on the solid medium after the incubation period was regarded as the MBC (Mann et al., 2008).

Table 1. Phytochemical components of stem bark extracts of *M. indica*.

Phytoconstituents	Water	Ethanol	Hexane
Tannins	+	+	+
Saponins	+	+	+
Phenols	+	+	+
Glycogen	+	+	+
Flavonoids	+	+	+
Alkaloids	+	+	+
Cardiac gycosides	+	+	+

Key: + positive
- negative

RESULTS AND DISCUSSION

Results of the extraction with various solvents show that ethanol was the more efficient solvent with a yield of 19.6%, followed by water with 17.6% and then hexane 14.9%. The ethanol extract produced the highest yield amongst all the solvents. This is a clear indication that the solvent system plays a significant role in the solubility of the bioactive components and influences the antibacterial activity. Medicinal plants contain some pharmacologically active principles which over the years were exploited in herbal medicine for the treatment of a number of diseased conditions. Phytochemical screening of the stem bark of *M. indica* showed the presence of tannins, saponins, phenols, glycogen, alkaloids and cardiac glycoside but no flavonoids as detailed in Table 1. These compounds are known to be biologically active because they protect the plant against infection and predation by animals. Phytochemicals generally exert their antimicrobial activities through different mechanisms to that of synthetic drugs (Scalbert, 1991). Tannins for example, have been found to form irreversible complexes with proline- rich proteins resulting in the inhibition of the cell protein synthesis. This activity might have been exhibited against the test bacteria. Apart from antimicrobial activity, tannin also reacts with proteins to provide the typical tanning effect. Medicinally, this is important for the treatment of pneumonia, asthma and inflamed tissues. Tannins have important roles such as been stable and potent antioxidants. Herbs that have tannins as their main component are astringent in nature and are used for treating asthma, pneumonia, and dysentery (Levin et al., 1979), thus justifying the use of the plant in traditional medicine practice.

The antibacterial assays in this study were performed by the agar-well diffusion methods so that they can be qualified and quantified by measuring the zones of growth inhibition diameters, MIC and MBC values. The antimicrobial activity of the crude plant stem bark extracts is shown in Table 2. The susceptibility of the bacteria to the crude extracts on the basis of zones of growth inhibition varied according to microorganism and extracting solvent. Several authors have reported that the sizes of zones of growth inhibitions vary from one organism to another and from one plant to another at different concentrations (Mann et al., 2008; El-Mahmood et al., 2008) Ethanol extracts demonstrated the highest activity of 16 mm zone diameter against *S. aureus* and *E. coli*, followed by *S. pneumoniae* with 15 mm zone diameter and *K. pneumoniae* with a zone diameter of 14 mm at a concentration of 100 mg/ml. The growth of inhibition followed similar pattern when the other solvents were used, except that aqueous extracts gave larger zone sizes than hexane, and both were lower than ethanol. Streptomycin which served as positive control, showed activity measuring 27 mm for *E. coli, S. pneumonia* (28 mm), *S. aureus* (26 mm), *P. aeruginosa* (22 mm) and 28 mm against *K. pneumoniae*.

All the extracts from the different solvents demonstrated antimicrobial activity though to varying degrees with the ethanol extracts demonstrating the highest activity. *P. aerugonosa* and *E. coli* were less sensitive and *S. aureus* more susceptible, similar re-ports have been obtained by scholars (Odebiyi and Sofowora, 1999, El-Mahmood *et al*., 2008). These bacteria are leading cause of both hospital and community acquired infections and has greater virulence capabilities as well as resistant development than other bacteria. This broad spectrum activity should make it useful for the treatment of infections requiring prompt therapy and when the causative agents are not thought to be *E. coli* and *P. aeruginosa.* Variation in activity among different extrac-ting solvents and also amongst different bacterial strains has been reported (Falodun et al., 2006; Muhammad and Muhammad, 2005). Differences in polarity among various solvents have been reported to be accountable for the differences in solubility of plant active principles, hence variation in degree of activity. The hexane extracts however, demonstrated the least activity against all the test bacteria. This may be so because hexane has been reported to be a poor extraction solvent. Results also showed that activity of all the extracts were concentration dependent. Similar results have been reported by several researchers. Highest activity was demonstrated by the standard antibiotic streptomycin (control). This is because

Table 2. Antibacterial activity of the stem bark extracts of *M. indica*.

	Zone of inhibition Diameter (mm)			
Organisms (control)	**Water**	**Ethanol**	**Hexane**	**Streptomycin**
E. coli	15	16	10	27
S. pneumoniae	13	15	9	28
S. aureus	10	16	11	26
P. aeruginosa	8	8	7	22
K. pneumoniae	14	13	9	28

Table 3. Effect of temperature on the efficacy of *M. indica* stem bark extracts.

Organisms	**Water**		**Ethanol**		**Hexane**		**Ethanol (control)**
Organisms	**10℃**	**100℃**	**10℃**	**100℃**	**10℃**	**100℃**	**NT**
E. coli	9	14	12	15	8	10	16
S. pneumoniae	10	15	15	17	9	13	15
S. aureus	10	16	14	20	10	14	16
P. aeruginosa	8	9	7	10	7	8	8
K. pneumoniae	11	15	14	18	11	15	7

Key: NT –not treated

the antibiotic is in pure state and has refined processes that have established it as a standard antibiotic (El-Mahmood and Amey, 2007).

The organisms used for the purpose of this investigation are associated with respiratory tract infections. Results of this investigation therefore have shown that *M. indica* is a potential source of antibiotic substances for drug development for use against this group of organisms. In earlier works, however, *K. pneumoniae* was observed to be resistant to the aqueous, methanol and ethanol bark extracts of eight plants used for traditional medicine in Paraguay. In this investigations however, ethanol bark extracts inhibited the growth of *K. pnuemoniae* significantly.

The effect of temperature on the efficacy of the crude extracts of the stem bark was recorded in Table 3. Ethanolic extracts at 10℃ inhibited the growth of *E. coli* by producing a zone diameter of 12 mm and at 100℃ 15mm,while for S*. pneumonia* the zone diameter was 15 mm at 10℃ and 17 mm at 100℃, for *S. aureus* the zone diameter was 13 mm 10℃ and 18 mm at 100℃, for *P. aeruginosa,* the zone diameter was 7 mm at 10℃ and 10 mm at 100℃, for *K. pneumoniae* , the zone diameter was 14 mm at 10℃ and 18 mm at 100℃ and for *S. aureus,* the zone diameter was 14 mm at 10℃ and 100℃ 20 mm. A similar pattern of zone inhibition was observed for the other extracts. However, aqueous extracts gave larger zone sizes than hexane extract and both were lower than ethanol extract. In terms of the effect of temperature on activity of the crude extracts, results showed that increase in temperature of the crude extracts increased the activity of the crude extracts. This could suggest the reason why traditional healers often boil plant extract before they are taken by the sick persons.

Table 4 showed antimicrobial activity of the crude extract at pH 2 and pH 10. Result showed that adjustment towards alkalinity had slight diminishing effect on the activities of the extracts. For instance, at pH 2, the ethanol extracts demonstrated the activity of 14 mm against *K. pneumoniae*, 9 mm against *P. aeruginosa* and 12 mm against *E. coli*. But at pH 10, the activities reduced to 10 mm for *K. pneumoniae*, 7 mm for *P. aeruginosa* and 8 mm E*. coli*. Effect of pH on activity indicated that test organisms were more susceptible to acidic pH of the crude plant extracts than to the alkaline pH of the same crude extracts. This is an indication that the crude plants can be stable under the acidic conditions of the stomach and the gastro-intestinal tract and therefore can be formulated to be taken orally.

The basic quantitative measurement of *in vitro* activity of antimicrobial agents with antimicrobial potential is the MIC and the MBC. Demonstration of low MIC and MBC values by especially the ethanol extracts is an indication that the phytoconstituents of the plant have therapeutic properties and therefore justifies its traditional medicinal uses. Ethanol stem bark extract showed minimum inhibitory concentration (MIC) at 100 mg/ml for *E. coli*, 50 mg/ml *S. aureus* and 100 mg/ml *P. aeruginosa* and 50 mg/ml for *S. pneumonia* and *K. pneumoniae.* Where as the minimum inhibitory concentration of the aqueous extract at 100 mg/ml was recorded for *E. coli*, *S. aureus* and 200 mg/ml, *P. aeruginosa* and for *S. pneumoniae* and *K. pneumonia* the minimum inhibitory concentration was at 100 mg/ml. Hexane extract showed minimum inhibitory concentration at 100 mg/ml for all the test organisms except *P. aeruginosa* which had MIC of 200

Table 4. Effect of pH on the efficacy of stem bark extracts of *M. indica*.

Organisms	Water		Ethanol		Hexane		Ethanol (control)
	pH 2	pH 10	pH 2	pH	pH 2	pH 10	NT
E. coli	10	7	12	8	8	9	16
S. pneumoniae	12	9	14	10	9	9	15
S. aureus	14	10	15	11	9	8	16
P. aeruginosa	8	7	9	7	8	7	8
K. pneumoniae	13	9	14	10	10	8	13

Key: NT –not treated

Table 5. The MIC (mg/ml) and MBC (mg/ml) of crude stem bark extracts of *M indica*.

Organism	Extract concentration (mg)					
	Water		Ethanol		Hexane	
	MIC	MBC	MIC	MBC	MIC	MBC
E. coli	50	100	50	50	100	200
S. pneumoniae	12.5	50	12.5	50	100	200
S. aureus	50	100	50	50	100	200
P. aeruginosa	100	200	50	100	200	400
K. pneumoniae	50	50	25	25	100	100

mg/ml.

The result of minimum bactericidal concentration produced by the crude extracts of stem bark of *M. indica* is shown on Table 5. Ethanolic extract showed minimum bactericidal concentration at 50mg/ml for all test organisms except *P. aeruginosa* which gave MBC value of 200 mg/ml. Aqueous extract gave minimum bactericidal activity at concentration of 100mg/ml for *E. coli* and 200 mg/ml for *P. aeruginosa* and 50 mg/ml for *K. pnuemoniae* and *S. pneumonia.* While an MIC of 50 mg/ml was recorded for *S. aureus*. The MBC values for the hexane extract were 200 mg/ml for *E. coli*, 100mg/ml for *K. pneumoniae*, *S. aureus*, *S. pnuemoniae* and 400 mg/ml for *P. aeruginosa.* The MIC and MBC values obtained in this study as well as the relatively large zones of growth inhibition against the test bacteria which frequently display above average resistance to most antibiotics and disinfectants are indications of the potency of the bioactive compounds in the plant material. The ability of the crude extracts to inhibit the growth of such pathogenic bacteria as those used in this study is an indication that *M. indica* is a medicinal plant and can be used as a source for developing broad spectrum antibiotics, which further validates its use in traditional herbal medicine to treat a variety of infections including those associated with respiratory tract infections. The observed antibacterial activity of the crude extracts suggests that it may play a dual role in medicine and food systems, where it can be used as preservative. However, potential use of the *M. indica* in the food and the pharmaceutical Industries is dependent on the purification, identification and characterization of the bioactive compounds reported to be present in this and other studies.

Conclusion

This study showed that *M. indica* stem bark used in this study posses antimicrobial activity against some organisms associated with infectious diseases. It therefore suggests that the plant could be a source of oral drugs to be used in the treatment of respiratory tract infections and diseases and may be a source for industrial drug production.

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