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Phytochemical Screening and Antimicrobial Properties of the Ethanolic Root Extract of *Tamarindus indica* L.

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Abstract The phytochemical constituents and the antimicrobial activities of the ethanolic root extract of *Tamarindus indica* L. were evaluated. The qualitative and quantitative phytochemical screening of the crude extract were carried out using GC-MS, Infra-red and UV spectrometric analytical methods. The antimicrobial activities of ethanolic root extract of *T. indica* L., was assessed on some bacterial isolates such as *Escherichia coli*, *Staphylococcus aureus*, *Proteus mirabilis* and *Pseudomonas aeruginosa* to estimate the inhibition zone in mm, using agar diffusion method. The result of the analysis revealed the presence of flavonoids, tannins, alkaloids, steroids, phenolic compounds and cardiac glycosides. Among these phytochemicals, tannins and cardiac glycosides were the highest with concentrations of 175.21 mg/kg and 167.82 mg/kg respectively, while the lowest was flavonoid with a concentration of 0.076 mg/kg. Phlobatanins, terpenoids, anthraquinones and saponins were absent. The GC-MS analysis showed 9 peaks, with the highest having a retention time of 28 .52 minutes while the lowest had a retention time of 12.77 minutes. Compounds like hexadecanoic acid (Rt: 19.95, 14.34%), methyl, alpha D-mannofuranoside (Rt: 17.18, 27.17%) and 9-octadecanoic acid (Rt: 22.80, 41.59%) were detected. The Infra-red and UV Spectrophotometric analyses showed the availability of the hydroxyl (-OH) and carbonyl (C=O) groups. Activity of the plant extract varied with concentration (mg/ml). At 5.00 mg/ml of extract, *S. aureus* was the most susceptible to the ethanolic root extract of *T. indica*, while the least susceptible was *E*. coli. The presence of the secondary metabolites in the root extract of *T. indica* L., is perhaps the reason for its medicinal properties. The result revealed that ethanolic root extract of *Tamarindus indica* L., has antimicrobial properties as shown by its activity on test bacterial strains.

Keywords *Tamarindus indica* L., ethanolic extract, root, antimicrobial, phytochemical, *Escherichia coli*, *Staphylococcus aureus*, *Proteus mirabilis* and *Pseudomonas aeruginosa*

Introduction

Plants have always played a key role in the treatment of different ailments in man and animals all over the world. In developing countries, researchers are still working on plants and plant products. Thus, recognition of natural products globally is on the rise. Herbal medicine is an important part of both traditional and modern system of medicine [34]. *Tamarindus indica* L., belongs to the Dicotyledonous family: Fabaceae, sub-family: Caesalpiniaceae, which is the third largest family of flowering plants with a total of 727 genera and 19, 327 species [19]. The

tamarind (*Tamarindus indica* L.) is a tree-type of plant. It is known to be indigenous to tropical Africa but has become naturalized in North and South America; ranging from Florida to Brazil, and is also cultivated in some subtropical countries like China, India, Pakistan, Philippines, Java and Spain [18]. It has more than one seed leaf hence, it is a dicotyledonous plant [21]. [20] revealed the highest growth percentage and further growth of tamarind seed occurred after pretreatment with methanol for 10 minutes. Seeds soaked in methanol, ethanol and tetraoxosulphate (vi) acid for 10 minutes gave rise to seedlings with high vigour [13]. Leaves reduce inflammatory swelling, tumours, ring worm, diseases of blood, small pox, ophthalmia and other eye diseases, ear ache, snake bite [4]. In Zimbabwe, the leaves are added to soup and the flowers are used in salads [35]. Unripe fruit pulp is an astringent, to the bowel and cure "vata" [3]. In Ghana, the pulp is mixed with sugar and honey to make a sweet drink. 'Jugo' and 'fresco de tamarindo' are favourite tamarind drinks in South America [9]. Bark heals ulcer, liver complaints [3]. In Zambia, bark tannins are used in the preparation of ink and for fixing dyes. The unsaponifiable matter from the seed oil contains: β-amyrin, compesterol, β-sitosterol [37], [25] and [2]. Pulp contains different organic acids like: tartaric acid, acetic acid, citric acid, formic acid, malic acid, and succinic acid.

The aim and objective of this study was to determine the phytochemical constituents and the antimicrobial properties of the ethanolic root extract of *Tamarindus indica* L.

Materials and Methods

Collection and Identification of Plant Material.

The roots of *Tamarindus indica* L. were collected, from Bauchi State, Nigeria. The plant was identified by Prof. MacDonald Idu and deposited at the Department of Plant Biology and Biotechnology, University of Benin, Herbarium, with a Voucher No. - UBHf0292.

The fresh roots of *Tamarindus indica* L. were cut from the main plant, rinsed in water and spread on laboratory tables where they were dried under room temperature. It was reduced to fine powder with the aid of a mechanical grinder. The mass of the granulated sample was 750 g. The sample was then macerated using ethanol to get a percentage yield of 98.68 %.

Phytochemical Screening

The ethanolic extract was subjected to standard phytochemical screening for different constituents such as flavonoids, tannins, alkaloids, steroids, phenolic content and cardiac glycosides as described by [36].

Standardization and preparation of the microbial innocula

The test organisms (clinical bacterial isolates) used for the study were *Escherichia coli, Staphylococcus aureus, Proteus mirabilis* and *Pseudomonas aeruginosa.* The microbial isolates were obtained from the laboratory stock of the Department of Microbiology, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria where they were also identified. 2 ml of Dimethyl Sulphoxide (DMSO) was added to 3.5 g, 2.5 g, 1.5 g and 0.5 g of ethanolic extract and made up to the mark with water to obtain a concentration of 35 mg/ml, 25 mg/ml, 15 mg/ml and 5 mg/ml respectively. 16 plates were poured; 12 MIC and 4 sensitivity. 0.5 ml solution of various concentration of extract, were poured into the agar wells (bored holes of 6 mm in diameter on the agar), using a sterile syringe. It was then allowed to diffuse for 1 hour, and then incubated at 37 ^{0}C for 24 hours (i.e the 12 plates for MIC). 1 g positive disc placed on a plate containing gram positive bacteria. While three (3) gram negative disc placed on a plate containing *E. coli*, *P. aeruginosa* and *Proteus mirabilis* respectively.

Extract Dilution Method

2 ml of Dimethyl Sulphoxide (DMSO) was added to 3.5 g, 2.5 g, 1.5 g and 0.5 g of ethanolic extract and made up to the mark with water to obtain a concentration of 35 mg/ml, 25 mg/ml, 15 mg/ml and 5 mg/ml respectively. 16 plates were poured; 12 MIC and 4 sensitivity. 0.5 ml solution of various concentration of extract, were poured into the agar wells (bored holes of 6 mm in diameter on the agar), using a sterile syringe. It was then allowed to diffuse for 1

hour, and then incubated at 37 ^{0}C for 24 hours (i.e the 12 plates for MIC). 1 g positive disc placed on a plate containing gram positive bacteria. While 3 gram negative disc placed on a plate containing *E. coli*, *P. aeruginosa* and *Proteus mirabilis* respectively.

Microbial Inocula Preparation for Susceptibility Testing

The inocula of the bacterial isolates were prepared by growing each pure isolate in nutrient broth at 37 ^{0}C for 24 hours. After incubation, 1 ml of the diluted cultures of the microbial isolates in normal saline solution, was inoculated unto the solidified nutrient agar at 45 ^{0}C using a Pasteur pipette.

Susceptibility Testing

The agar-well diffusion method, suitably modified was adopted for the susceptibility studies [15]. The media used was nutrient agar to test the susceptibility of bacteria. The media was prepared according to the manufacturer's guide and sterilized in an autoclave at 121 ^{0}C for 15 minutes after which they were poured into petri dishes and allowed to set. The plates were inoculated with the respective test organisms in triplicate culture plates. Using a sterile cork borer of 6 mm diameter, four (4) adequately spaced wells per plate were made into the culture agar plates. Varying concentrations of 35 mg/ml, 25 mg/ml, 15 mg/ml and 5 mg/ml of the plant extracts were poured into the four holes that have been labeled previously to correspond to each of the concentrations of the extract. The plates were left standing on the work bench for 30-40 minutes to allow pre-diffusion time. The bacterial inoculated plates were incubated at 37 ^{0}C for 24 hours. Zones of inhibition around the wells indicated antimicrobial activity of the extract against the test organisms. The diameters of these zones were measured diagonally in millimeter with a ruler and the mean value for each organism from the triplicate cultured plates were recorded. Using the agar-well diffusion technique, an already made gram positive and gram negative (Asodisks Atlas Diagnostics, Enugu, Nigeria) standard antibiotic sensitivity disc bought from a laboratory chemical equipment store in Benin City was used as positive control for the bacteria isolates. Distilled water was used as negative control for all the test isolates. All the plates used for control were incubated at 37 ^{0}C for 24 hours. The zones of inhibition were measured after incubation and recorded.

Determination of Minimum Inhibitory Concentrations (MICs).

The standard agar dilution protocol with doubling dilution was used to determine the MICs of the extract [29]. A 100 mg/ml concentration of each of the extract was prepared in sterile distilled water, and diluted to achieve a decreasing concentration of 35, 25, 15 and 5 mg/ml respectively. Each dilution was introduced into nutrient agar plates and potato dextrose agar plates already seeded with the respective test organism. All plates were incubated at 37 ^{0}C for 24hours. The minimum inhibitory concentration (MIC) of extract for each test organism was regarded as the agar plate with the lowest concentration without growth.

Minimum Bactericidal Concentration (MBC) Determination.

The minimum bactericidal concentration (MBC) of the extract was determined by the method as described by [14]. Samples were taken from the MIC test bacteria plates with no visible growth. These were sub-cultured unto freshly prepared nutrient agar plates and incubated at 37 ^{0}C for 24 hours. MBC was taken as the concentration of the extract that did not show any growth on the new set of agar plate.

Results

Phytochemical analysis of ethanolic extract of *T. indica.*

The results of the phytochemical analysis of the ethanolic root extract of *T. indica* L. revealed the presence of flavonoids, tannins, alkaloids, steroids, phenolic compounds and cardiac glycosides and the absence of phlobatanins, saponins, terpenoids and anthraquinones (Table 1).

Table 1: Phytochemical composition of the ethanolic root extract of *T. indica* L.

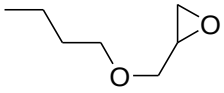
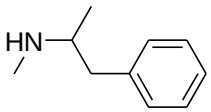
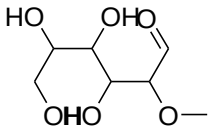
Chemical Components	Inference
Flavonoids	+
Tannins	+++
Alkaloids	+
Steroids	+
Phenolic Content	++
Cardiac glycosides	+++
Phlobatanins	-
Saponins	-
Terpenoids	-
Anthraquinones	-

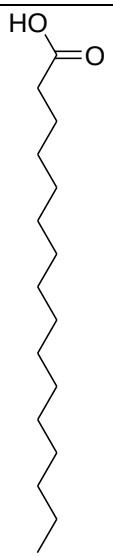
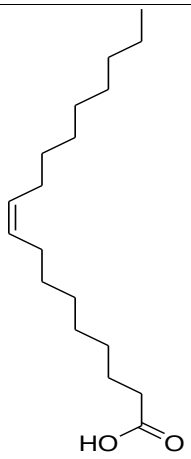
Key: + = 0 to 30 mg/kg; ++ = 30 to 100 mg/kg; +++ = > 100 mg/kg; - = Absent 0.076

GC-MS Analysis

The compounds detected in the GC-MS analysis, giving their names, molecular structure, molecular formula, retention time, peak area, molecular weight, reference index and uses are in Table 2.

Table 2: Summary of compounds detected in the GC-MS analysis of the ethanolic extract of the root of *Tamarindus indica* L

S/N	Compound Name	Structure	Molecular Formula	Retention Time	Peak Area (%)	Molecular Weight (g)	Reference Index	Uses
1	Butoxymethyl oxirane		$C_7H_{14}O_2$	12.77	2.72	130	12.567	It is used in the preparation of penicillin in the pharmaceutical industry [10].
2	N, alpha-dimethyl phenylethylamine		$C_{10}H_{15}N$	13.41	1.78	149	13.333	Drugs made from this compound could be used in the treatment of obesity [17].
3	Methyl,alpha D-Mannofuranoside		$C_7H_{14}O_6$	17.18	27.17	194	16.450	It has also been discovered that some chemical substances from this compound have anti-fungal properties [7].

4	Hexadecanoic acid (Palmitic acid)		$C_{16}H_{32}O_2$	17.59	0.96	256	17.533	In the health sector an antipsychotic drug, known as paliperidone palmitate (with the trade name; INVEGA sustenna), which is used in the treatment of schizophrenia has been discovered [12].
5	Hexadecanoic acid (Palmitic acid)		$C_{16}H_{32}O_2$	19.95	14.34	256	19.825	Hexadecanoic acid is rich in vitamin A [38].
6	9-Octadecanoic Acid (Oleic acid)		$C_{18}H_{34}O_2$	22.80	41.59	282	22.475	It could be used to soften and sooth the skin [5].
7	Hexadecanoic acid (Palmitic acid)		$C_{16}H_{32}O_2$	23.18	8.76	256	23.083	Some sub-cellular trafficking of proteins could be attributed to products from this **c**ompound [31].
8	Hexadecanoic acid (Palmitic acid)		$C_{16}H_{32}O_2$	26.26	1.96	256	26.150	It has protein to protein reaction modulating effect [4].
9	Hexadecanoic acid (Palmitic acid)		$C_{16}H_{32}O_2$	28.52	0.73	256	28.450	It helps in coordinating activities that are needed in memory formation [26].
			TOTAL		**100**			

Infra-Red and UV- Spectroscopy: The result of the extract that was further analysed and characterized using the Infra-Red Spectrophotometer (FTIR-8400S FOURIER TRANSFORM SERIES) and the UV- Spectrophotometer (UV-2500PC Series), is shown in Table 3 and 4.

Table 3: FT-IR Spectroscopic analysis of the ethanolic root extract of *Tamarindus indica* L

S/N	Frequency	Bond	Compound
1	3301- 3513 cm^{-1}	O – H	Hydroxyl groups
2	2997 cm^{-1}	C – H stretch of-C-H	Alkyl groups (CH_3, CH_2,CH)
3	2104 cm^{-1}	C = C stretching vibration	Alkynes, Nitriles,
4	1532 – 1639 cm^{-1}	C – C bending vibration	Alkane
5	1437 – 1389 cm^{-1}	Bending vibrations of $CH_2$and CH_3	Aromatic group
6	1272 cm^{-1}	C – O	Acids, Esters, Anhydrides
7	1057 cm^{-1}	C – O	Alcohol RCH_2OH

Table 4: UV Spectroscopic analysis of the ethanolic root extract of *Tamarindus indica* L

S/N	Frequency	Bond	Compound
1	659 nm	O – H	Hydroxyl Group
2	651 nm	C=O	Carbonyl Group

Table 5: The effect of the ethanolic root extract of *Tamarindus indica* L., on the test strains at various concentrations

	Zones of Inhibition (mm)				
Test organisms	**35 mg/ml**	**25 mg/ml**	**15 mg/ml**	**5 mg/ml**	***p- value***
Escherichia coli	3.00 ± 0.58	3.30 ± 0.58	1.30 ± 0.58	1.00 ± 0.58	0.035*
Staphylococcus aureus	2.60 ± 0.29	2.85 ± 0.29	2.10 ± 0.29	3.50 ± 0.29	0.002*
Proteus mirabilis	2.65 ± 0.13	2.35 ± 0.13	2.40 ± 0.13	2.00± 0.13	0.000*
Pseudomonas aeruginosa	3.20 ± 0.39	2.35 ± 0.39	2.25 ± 0.39	1.30 ± 0.39	0.010*

*P < 0.05 are significantly different.

Table 6: Effects of the antibiotics on the test organisms (*Proteus mirabilis* and *Pseudomonas aeruginosa;* gram negative bacteria) and (*Staphylococcus aureus;* a gram positive bacterium)

	Zones of Inhibition (mm)				
Test organisms	**Streptomycin (5 mg/ml)**	**Tarivid (5 mg/ml)**	**Amoxicillin (5 mg/ml)**	**Chloramphenicol (5 mg/ml)**	***p- value***
Proteus mirabilis	2.30 ± 0.08	2.40± 0.08	2.20 ± 0.08	2.60± 0.08	0.00*
Pseudomonas aeruginosa	2.20 ± 0.09	2.60± 0.09	2.50± 0.09	2.60± 0.09	0.00*
	Gentamicin (5mg/ml)	**Ciprofloxacin (5mg/ml)**	**Erythromycin (5mg/ml)**	**Pefloxacin (5mg/ml)**	
Staphylococcus aureus	2.00 ± 0.06	1.80 ±0.06	1.90 ±0.06	2.10 ±0.06	0.00*

*P < 0.01 are significantly different.

Table 7: Minimum inhibitory concentration and minimum bactericidal concentration of the ethanolic root extract of *Tamarindus indica* L.

Bacterial Isolates	MIC (mg/ml)	MBC (mg/ml)
E. coli	50	50
P. aeruginosa	25	40

Discussion

Analysis of the ethanolic root extract of *Tamarindus indica* L**.** revealed the presence of several phytochemicals which include flavonoids, tannins, alkaloids, steroids, phenolic content and cardiac glycosides (Table 1). Among these phytochemicals, tannins and cardiac glycosides were the highest with concentrations of (175.21) and (167.82) respectively while the lowest was flavonoid with concentration of (0.076) (Table 1). In a related phytochemical study on the root bark of *T. indica*, phytochemical constituents like; phenolic compounds and cardiac glycosides were present [30]. Major components detected from the ethanolic root extract of *Tamarindus indica* L., are hexadecanoic acid (palmitic acid) (Rt: 19.95, 14.34%), a saturated fatty acid; methyl, alpha D-mannofuranoside (Rt: 17.18, 27.17%), a glycoside and 9-octadecanoic acid (oleic acid) (Rt:22.80,41.59%) a high molecular weight unsaturated fatty acid while minor components among others were butomethyloxirane (Rt:12.77,2.72%), an heterocyclic compound and N, alpha –dimethyl phenylethylamine (Rt:13.41,1.78%) which suggests an alkaloid due to the presence of an amine group (Table 2). The chemical abstract service library indicated high possibility for the presence of hexadecanoic (palmitic acid) acid due to the peak signals observed at peak 4,5,7,8 and 9. In a related study on the GC-MS characterization of some essential oil, hexanoic compound was detected at a retention time of 4.9, while phenolic compound was detected at a retention time of 10.35 [24]. Thus the ethanolic root extract of *Tamarindus indica* L., contains high level of oleic acid (9-Octadecanoic acid), a good unsaturated fatty acid present in most edible oil and required nutritionally in human diets and for industrial purposes. The GC-MS analysis is a highly rated technique for characterizing compounds of herb extracts [24].

From the Infra-Red Spectrophotometric analysis carried out, it was observed that the sample showed 12 peaks, the highest was 3981.21 with an intensity of 80.726, a corresponding intensity of 0.013, Base height of 3990.85, Base length of 3980.24, Area of 0.984 and a corresponding area of 0.001. While the lowest was 416.64 with an intensity of 27.844, a corresponding intensity of 1.521, Base height of 424.35, Base length of 406.03, Area of 10.005 and a corresponding area of 0.257, which corresponds with that of [3]. The band around 3301 – 3513 cm^{-1} are assigned to O - H stretching vibration of hydro peroxide. While 2997 cm^{-1} shows C – H asymmetric and symmetric stretching vibration of aliphatic CH_2. 2104 cm^{-1} peak shows a peak of a double bond of weak C = C stretching vibration. The band around 1532 – 1639 cm^{-1} these region arise from complex ring deformation and is usually C – C bending vibration. Bending vibrations of CH_2 and CH_3 aromatic group observed at 1437 – 1389 cm^{-1}. At 1272 – 1057 cm^{-1}, the major peaks in these spectra arise from stretching vibration of C – O (Table 3).

Also, in the UV- Spectrometric analysis, it was observed that the sample showed 15 peaks, the highest peak value was gotten at a wavelength of 659.50 nm and an absorbance value of 0.085. While the lowest peak value was gotten at a wavelength of 204.00 nm and an absorbance value of 4.427. The various absorption peaks at 200 – 300 nm are at ultra violet region (305, 288, 274, 266, 253, 246, 239, 232, 225, 217, 211, 204 nm). Therefore there is no visible sign of light being absorbed in this region, making the sample analysed colourless in that region. From the absorption peaks, no lambda – mass was obtained (λ max; which is the wave length that corresponds to the highest absorption). At 434 nm the light absorbed is violet. At 651 and 659 nm the light absorbed is red (Table 4), corresponding with that of [33].

The antimicrobial activity of the ethanolic root extract of *Tamarindus indica* L., was assessed on some bacterial isolates such as *Escherichia coli*, *Staphylococcus aureus*, *Proteus mirabilis* and *Pseudomonas aeruginosa* to estimate the inhibition zone in mm. The activity of the plant extract varied with concentration (mg/ml) of the ethanolic root extract of *T. indica* (Table 5). At 5.00 mg/ml of extract, *S. aureus* was the most susceptible to the ethanolic root extract of *T. indica*, while the least susceptible was *E. coli*. At 15.00 mg/ml, *Proteus mirabilis* and *Pseudomonas aeruginosa* were the most susceptible, while at 25.00 and 35.00 mg/ml, *E. coli* and *P. aeruginosa* were the most susceptible respectively. However it is remarkable and note worthy that the activity of the plant extract on the tested strains did not increase or decrease linearly with respect to concentration. (Table 5). The MIC of the of the ethanolic root extract of *T. indica* showed that when the concentration increased, the zone of inhibition increased, this could be as a result of increase in dose leading to increasing effect. As could be seen in Table 5. The antimicrobial activity of the ethanolic root extract of *T. indica* was compared with some regularly used antibiotics to determine the potency of *T. indica*. The result revealed *T. indica* ethanolic root extract at 35.00 mg/ml to be more

potent, when compared with other antibiotics such as gentamicin, streptomycin, amoxicillin, chloramphenicol, ciprofloxacin, tarivid, pefloxacin and erythromycin at 5 mg/ml respectively, as all the bacterial isolates were susceptible to the ethanolic root extract of *T. indica* (Table 6). The table shows the zones of inhibition of selected antibiotics on *Proteus mirabilis, Pseudomonas aeruginosa, and Staphylococcus aureus*. The ethanolic root extract of *T. indica* at 35.00 mg/ml had a zone of inhibition of 2.65 on *Proteus mirabilis,* whereas streptomycin at 5 mg/ml had a zone of inhibition of 2.30 on the same test organism. Also, the ethanolic root extract of *T. indica* at 35.00 mg/ml had a zone of inhibition of 3.20 on *Pseudomonas aeruginosa,* while chloramphenicol at 5 mg/ml had a zone of inhibition of 2.6 on the same test organism. On a like note, the ethanolic root extract of *T. indica* at 35.00 mg/ml had a zone of inhibition of 2.60 on *Staphylococcus aureus,* whereas erythromycin at 5 mg/ml had a zone of inhibition of 1.90 on the same test organism.

[6] also reported that ethanolic extract of *Tamarindus indica* L. fruit pulp have strong antibacterial activity against *Escherichia coli, Klebsiella pneumoniae*, *Salmonella paratyphi* A and *Pseudomonas aeruginosa*, whereas aqueous extract produce weak antibacterial activity except against *Pseudomonas aeruginosa*. The use of ethanol as a solvent for extraction is remarkable, as [11] reported that among six different extracts of *Tamarindus indica* leaves, ethanolic extract had considerable activity against both gram negative and positive bacteria and fungi.

In a related study, it was observed that the methanolic extract of *Tamarindus indica* L. fruit pulp showed the presence of antibacterial properties against most tested bacterial strains when compared with the antibiotic chloramphenicol [8]. The various zone of inhibition in a decreasing order of sensitivity were; *Pseudomonas aeruginosa* (12.00 mm), *Escherichia coli* (11.60 mm), *Staphylococcus aureus* (11.30 mm), *Proteus vulgaris* (11.00 mm), *Bacillus cereus* (11.00 mm), and *Staphylococcus epidermidis* (10.60 mm).

Accordingly, the results obtained from the current study were *Escherichia coli* (30.00 mm/disc), *Staphylococcus aureus* (26.00 mm/disc), *Proteus mirabilis* (27.00 mm/disc), and *Pseudomonas aeruginosa* (32.00 mm /disc). These results of the crude extract are promising when compared with the other compared antibiotics **(**gentamicin, streptomycin, amoxicillin, chloramphenicol, ciprofloxacin, tarivid, pefloxacin and erythromycin) which is in pure form. Zone of inhibition above 10 mm is considered as good antibacterial activity [1]. The Minimum inhibitory concentration and minimum bactericidal concentration of the ethanolic root extract of *Tamarindus indica* L. were remarkable as compared with [1], [8], [29] and [14], (Table 7).

Conclusion

This research work has provided some preliminary information on the phytochemical constituents of the *Tamarindus indica* L., root using qualitative standards. It has been able to reveal the presence of the chemical compounds present in the plant under study using GC-MS, Ultra Violet and Infra-red spectroscopy. It has also revealed the antimicrobial action of the ethanolic root extract of *Tamarindus indica* L., on the test microbial isolates (both with thick and thin peptidoglycan cell wall). Hence, it could perhaps be seen as a potential source of antimicrobial agent. The presence of the secondary metabolites in the root extract of *T. indica* L., is perhaps the reason for its medicinal properties. This work concur with the medicinal claim of the *Tamarindus indica* root as used in traditional medicine. I would recommend that further studies be carried out on the use of other solvent for extraction, chemical characterization and structural elucidation of the isolated compound. I would also recommend further pharmacological evaluations and toxicological studies on the root of *Tamarindus indica* L.

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