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The Comparative Study of Phytochemical Constituents and Antibacterial Activities of Methanolic Extracts of the Leaf and Stem Bark of *Anogeissus leiocarpus* (DC.) Guill & Perr

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Abstract

This study was aimed at investigating and comparing the phytochemical constituents and antibacterial activities of methanolic extracts of the leaf and stem bark of *Anogeissus leiocarpus* plant against *Eschericia coli*, *Klebsiella pnuemoniae*, *Pseudomonas aeruginosa*, *Staphylococcus* aureus and *Proteous mirabilis* isolated from patients suffering from urinary tract infection. 500 g of each of the pulverised plant parts were used for extraction using a Soxhlet extractor. Standard chemical procedures were used for qualitative and quantitative phytoconstituents present in the plant extracts. The agar-well diffusion method and the tube dilution method were adopted to determine the antibacterial activity and minimum inhibitory concentration of the extracts, respectively. Phytochemical screening of the crude extracts of the leaf and stem bark revealed that both extracts contain alkaloids, flavonoids, saponins, tannins, phenols, and steroids, whereas only the stem bark consisted of cardiac glycosides. The result shows that the stem bark extract was more effective in inhibiting all five tested pathogens with zones of inhibition ranging between 10.88±0.56 and 26.24±0.00 as compared to the leaf extract 9.00±0.65 and 16.00±1.50, while the standard antibiotic (nitrofurantoin) exhibited greater activity with zones of inhibition ranging between 24.00±0.25 and 32.00±0.52. The phenolic and flavonoids contents were found to be higher in the

stem bark (122.72±0.00 and 72.16±0.05) than the leaf (89.25±0.05 and 48.28±0.00, respectively). The MIC and MBC ranged between 2.5–25 mg/ml and 5–25 mg/ml for the leaf, whereas 0.625–10 mg/ml and 2.5–20 mg/ml for the stem bark. These results support the use of stem bark in herbal medicines for the treatment of patients with urinary tract infections.

Key words: *Anogeissus Leiocarpus*, Methanolic Extracts, Phytocontituents, Antibacterial

Introduction

World Health Organisation (WHO) defines traditional medicines as knowledge, skills, and practices that are culturally diverse and used to cure or prevent physical or mental diseases (WHO, 2019). This definition is based on ideas, first-hand information, and beliefs. For over 80% of the world's population living in underdeveloped and impoverished countries, traditional plant-based medicines remain their main source of healthcare; their applications are a reflection of long-standing human interactions with the environment (Arbab, 2014; Bello et al., 2020; Namadina et al., 2021). Many compounds known as phytochemicals are found in plants that are employed in traditional medicine, and they have the potential to cure both viral and chronic illnesses. These compounds found in medicinal plants have been utilised as stimulants, analgesics, anti-inflammatory, anti-convulsive, antioxidants, antimicrobials, anti-tumors, and antimalarials due to their well-known therapeutic properties (Ali et al., 2017; Dahiru et al., 2021). There is a growing emphasis on using plant materials as a source of medicine for a variety of human ailments due to factors such as population growth, a lack of available drugs, rising treatment costs, side effects from several synthetic drugs, and drug resistance (Madubuike et al., 2017; Oloninefa et al., 2020). With the aim of finding innovative and potent medicinal molecules from plants that can prevent, treat, or cure diseases brought on by pathogenic microbes and oxidative stress, the World Health Organisation (WHO) has made the necessary preparations to carry out research (WHO, 2019). In Nigeria, Anogeissus leiocarpus is one such promising plant that is utilised to cure a variety of illnesses.

Anogeissus leiocarpus (DC.) Guill & Perr, a deciduous tree species that may reach heights of 15–18 m and diameters of up to 1 m, is a significant ethno-

medicinal plant in both Africa and Asia (Namadina et al., 2021; Mubarak et al., 2023). (Udeozo et al., 2014; Ali et al., 2017; Dayok et al., 2018). The plant, also called the African birch or Axle-wood tree, is a member of the combretaceae family (Arabab, 2014; Sale et al., 2020). It is known as marke (Hausa), ayin (Yoruba), and atera (Igbo) in Nigerian (Stephen et al., 2020; Mubarak et al., 2023). The leaf, stem bark, twigs, and roots of Anogeissus leiocarpus are used to treat a variety of conditions, including gonorrhoea, wounds, fever, stomach infections, acute respiratory tract infections, and tuberculosis. Bioactive substances such terpenoids, alkaloids, flavonoids, and tannins are thought to be responsible for the plant's medicinal qualities (Arbab, 2014; Chidozie & Adoga, 2020; Valsan et al., 2021). There are numerous documented traditional uses for the plant; bronchitis, hay fever, and cough are treated with the infusion of leaves (Mann et al., 2014; Mubarak et al., 2023). The roots are utilised as chewing sticks because they are effective against fungal infections like dermatitis and mycosis, are thought to prevent oral infections, and are used to treat typhoid fever and malaria (Temitope et al., 2017). Stem bark decoction and maceration are used to treat a variety of illnesses, including helmintosis, schistosomiasis, leprosy, amoebic dysentery, and sexually transmitted infections, as well as anorexia, constipation, fatigue, itching, eczema, psoriasis, carbuncle sores, boils, and the removal of parasite cysts in the host (Mann et al., 2014; Sale et al., 2020; Usman et al., 2020). In a related finding, male Wister rats that were rendered sexually impaired by paroxetine showed reduced erectile dysfunction when exposed to stem bark from Anogeissus leiocarpus (Ademosun et al., 2019).

Studies have shown that the aqueous extract of the leaves possesses pharmacological properties that include antibacterial, anti-inflammatory, anti-diabetic, and wound-healing properties (Chidozie & Adoga, 2020). Comparably, the application of the plant in the traditional treatment of candidiasis was linked to the antifungal activity of the stem bark ethanol extract (Temitope et al., 2017). Additionally, pharmacological activities were observed against Klebsiella spp., Escherichia coli, and Pantoea agglomerana by butanol, hexane, and an aqueous extract of stem bark. The plant's phytochemical components were credited with this, and it was proposed that they could provide treatments for treating bacteria that are resistant to drugs (Stephen et al., 2020). The aim of this study was to assess the antibacterial activity and phytochemical content of methanolic extracts of Anogeissus leiocarpus plant leaves and stem bark against pathogenic bacteria isolated from patients with urinary tract infections, considering the various benefits of the plant.

MATERIALS AND METHODS

Collection of plant sample

The leaf and stem bark of *the Anogeissus leiocarpus* plant were collected from Uttachu village in Kontagora Local Government Area of Niger State (situated between latitude $39^0$19′N and $13^0$32′N and longitude $03^0$31′N and 08^0 22′E), located about 30km away from Kontagora. Samples collected were authenticated by a plant taxonomist at the Faculty of Life Sciences, Kebbi State University of Science and Technology, Aleru, Nigeria. A voucher specimen (KSUSTA/PSB/H/84DC.) was deposited in the herbarium of the institute.

Organisms/source

Clinical bacterial isolates obtained from urine samples of patients attending General Hospital Minna, Niger State, were used in this study. The bacterial isolates were subjected to various biochemical tests (catalase, coagulase, starch hydrolysis, indol, citrate utilisation, nitrate reduction, methyl red test, hydrogen sulphide reduction, sugar fermentation, etc.) for proper identification. Morphological and biochemical characterization of the isolates identified *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis,* and *Staphylococcus aureus* as bacterial pathogens responsible for urinary tract infections.

Ethical clearance

Ethical clearance to obtain clinical bacterial isolates from patients with urinary tract infections was sought from the Research Ethics and Publication Committee (REPC) of the Niger State Management Board. Confidentiality and privacy were respected during and after the conduct of the study, and all the data were kept secure and available only to the researcher.

Source of the media, solvent and reagents

All chemicals and reagents used for the analysis were of analytical grade (Amalar), manufactured by British Drug House Limited (BDH) in England, while the media were oxoid products.

Plant processing and extraction

The leaf and stem bark of *the Anogeissus leiocarpus* plant collected were air dried under shade for a period of one month and subsequently pulverised using electrical blander to form fine powders. About 500 g of each plant powder was used for the extraction using a soxhlet extractor (Abdullahi & Mainul, 2020).

Procedure

The powdered materials were exhaustively extracted with methanol under reflux in 200-ml conical flasks. The finely ground powder was placed in porous bags made of whatman fitter paper, which were placed in the chamber of the Soxhlet apparatus. The extracting solvent (100% methanol) in the flask was heated, and its vapours were condensed in a condenser. The condensed solvent was dropped into the thimble containing the plant material and extracted. When the level of liquid in the chamber reached the top of the syphon tube, the liquid content of the chamber was syphoned into the flask. The process was continued until a drop of solvent from the syphon tube did not leave residue when evaporated. Each of the extracts was concentrated *in vacuo* using a rotary evaporator, which ensured the evaporation of bulky solutions to a small volume concentration. The resultant concentrations were weighed and kept in the refrigerator prior to usage (Abdullahi & Mainul, 2020).

Phytochemical screening of the extracts

The standard methods used by Moniva *et al. (*2019; Huma *et al. (*2021; Yusuf *et al. (*2022) were employed for phytochemical analysis in order to identify some secondary metabolites such as tannins, alkaloids, flavonoids, glycosides, sterols, terpenes, saponins, coumarins, phenols, and anthraquinones.

Quantitative Estimation of phytochemical constituents

Phytoconstituents obtained from the leaf and stem bark extracts of *Anogeissus leiocarpus* were subjected to quantitative analysis using standard methods (Huma *et al.*, 2021; Mubarak *et al.*, 2023).

Quantitative Estimation of Alkaloids

To 1 ml of the test extract, 5 ml of pH 4.7 phosphate buffer was added, along with 5 ml of BCG solution, and the mixture was shaken with 4 ml of chloroform. The fractions were collected in a 110-ml volumetric flask and then diluted to adjust volume with chloroform. The absorbance of the complex in chloroform was measured at 470 nm against a blank prepared but without the extract of the plants. Atropine is used as a standard material, and the assay was compared with atropine equivalents.

Quantitative Estimation of flavonoids

Total flavonoid content was determined by the aluminium chloride method using catechin as a standard. 1 ml of the test fraction and 4 ml of water were added to a volumetric flask (10 ml). After 5 minutes, 0.3 ml of 5% sodium nitrite and 0.3 ml of

10% aluminium chloride were added. After a 6-minute incubation at room temperature, 2 ml of 1M sodium hydroxide was added to the reaction mixture. Immediately, the final volume was made up to 10 ml with distilled water. The absorbance of the reaction mixture was measured at 510 nm against a blank spectrophotometer. Results were expressed as catechin equivalent (mg catechin/g dried extract).

Quantitative Estimation of Saponins

Test extracts were dissolved in 80% methanol, 2 ml of vanillin in ethanol was added, mixed well, and 2 ml of a 72% sulfuric acid solution was added, mixed well, and heated on a water bath at 600 °C for 10 minutes. The absorbance was measured at 544 nm against the reagent blank. Diosgenin is used as a standard material, and the assay is compared with diosgenin equivalents.

Quantitative Estimation of Steroids

One millilitre (1 ml) of the test extract of the steroid solution was transferred into 10 ml volumetric flasks. Sulphuric acid (4N, 2 ml) and iron (III**)** chloride **(**0.5% w/v, 2 ml) were added, followed by potassium hexacyanoferrate (III) solution (0.5% w/v, 0.5 ml). The mixture was heated in a water bath maintained at 70±20 °C for 30 minutes with occasional shaking and diluted to the mark with distilled water. The absorbance was measured at 780 nm against the reagent blank.

Quantitative Estimation of Phenolic Compounds

The total phenolic content of the extract was determined with the Folin-Ciocalteus reagent (FCR). In the procedure, different concentrations of the fractions were mixed with 0.4 ml of FCR (diluted 1:10 v/v). After 5 minutes, 4 ml of sodium carbonate solution was added. The final volume of the tubes was made up to 10 ml with distilled water and allowed to stand for 90 minutes at room temperature. The absorbance of the sample was measured against the blank at 750 nm using a spectrophotometer. Gallic acid was used as a standard for the estimation of phenolic compounds.

Quantitative Estimation of Tannin

One milliliter (1ml) of the fractions was mixed with 0.5 ml of Folin reagent, and then it was saturated with 1 ml of Na_2CO_3, and 8 ml of distilled water was added to the final mixture. The solution, which was incubated for 30 min, was centrifuged, and the supernatant was analyzed at 725 nm. Tannic acid was used as a standard, and tannin content was expressed as mg tannic acid equivalent (TAE)/g.

Susceptibility testing of the methanolic extracts against the bacterial isolates

Methanolic extracts of the leaf and stem bark of *Anogeissus leiocarpus* were tested for antibacterial activity against the bacterial isolates obtained from patients with urinary tract infections. The agar-well diffusion method was used as described by Bello *et al*. (2020) and Tauheed *et* al. (2020).

Procedure

Thirty-nine gram (39 g) of Mueller Hinton agar were dissolved in a liter of distilled water in a conical flask. The mixture was sterilized in the autoclave at 1210 °C for 15 minutes, and the medium was allowed to ol to 450 °C. Sterile molten Mueller Hinton agar (20 ml) was dispensed into sterile petri dishes and allowed to set. A sterile cork borer of 6 mm was used to bore equidistant wells on the agar plates. One drop of the molten agar was used to seal the bottom of the bored wells using a micropipette so as to prevent the extracts from sipping beneath the agar. One hundred milligrams (100 mg), 150 mg, a and 200 mg of each fraction were weighed and dissolved in 5 ml of each 10% dimethyl sulfoxide (DMSO). 10 ml of DMSO was made up to 100 ml with distilled water to give 20 mg/ml, 30 mg/ml, and 40 mg/ml concentrations, respectively. Sterile cotton swab steaks were used to strike on the surface of the agar plates with the standardized test organisms, and 0.1 ml of the extract (20, 30, and 40 mg/ml) of the methanol fractions of the extracts was added separately to bored wells. 5 mg/ml of the standard drug (nitrofurantoin) was used as a positive control, while dimethyl sulfoxide (DMSO) served as a negative control. Thirty minutes of pre-diffusion time were allowed, after which the plates were incubated at 370 °C for 24 hours. The zone of inhibition (mm) was obtained by measuring the distance from the center of the well and subtracting the diameter of the cork borer. The above method was carried out in triplicate, and the mean of the result was taken. Any test with a ten-millimeter (10-mm) zone of inhibition was considered sensitive to the plant extract.

Determination of Minimum Inhibitions Concentration

The tube dilution method was used to determine the MIC of the active extracts as described by Prashik *et al.* (2020), with a slight modification. A series of two-fold dilutions of each extract, varying from 40 mg/mL to 0.039 mg/mL, was prepared in Mueller-Hinton broth. Zero point one millimetre (0.1 m) of each of the standardized test organisms (0.5 Macfiland inhibition standards) was added to each dilution. Two control tests were maintained for each batch. These include tubes containing extract and growth medium without inoculation and tubes containing growth medium and inoculum (organism control). The tubes were incubated at 370 °C for 24 hours and

checked for turbidity. The minimum inhibitory concentration (MIC) was determined as the highest dilution of the fraction that showed no visible growth.

Determination of Minimum Bactericidal Concentration (MBC)

The Minimum Bactericidal Concentration (MBC) was determined by sub culturing the tubes that showed no visible growth in the MIC determination on Mueller Hinton agar plates and incubating at 370 °C for 24 hours. The lowest concentration that yielded no growth on the plate was considered the MBC of the extract (Jane & Savina, 2021).

Data Analysis

The triplicate data reading values of inhibition zones in diameter and concentration values (MIC and MBC) were analyzed using the statistical package for social sciences (SPSS) software, version 22. Each experimental value was expressed in terms of mean±SD significance in different between the two groups and tested by a student t-test, assessed by comparing the corresponding p-value of the test. The p-values <0.05 were considered significant for the study.

RESULTS

Percentage yields of the leaf and stem bark of *Anogeissus leiocarpus* plant

The extractions of methanolic leaf and stem bark extracts revealed 132.90 g (27.18%) and 128.30 g (25.66%), respectively, as indicated in Table 1.

Table 1: percentage yield of *Anogeissus leiocarpus* plant extracts

Plant part	Quantity (g)	Solvent	Extract color	Yield (g)	Percentage yield (%)
Leaf	500	Methanol	Dark green	132.90	27.18
Stem bark	500	Methanol	Brownish	128.30	25.66

Preliminary phytochemical screening of the leaf and stem bark extracts

Table 2 displays the several phytoconstituents that were found in the leaf and stem bark extracts after a preliminary phytochemical screening. Alkaloids, flavonoids, saponins, tannins, phenols, and steroids are present in both extracts; cardiac glycosides are present exclusively in the stem bark extract. In both extracts, compounds such coumarin, terpenoids, and anthraquinones were missing (table 2).

Table 2: phytochemical constituents of *Anogeissus leiocarpus* plant

Phytochemical compound	Leaf	Stem bark
Alkaloids	+	+
Flavonoids	+	+
Tannins	+	+
Saponins	+	+
Terpenoids	-	-
Phenols	+	+

Cardiac glycosides	-	+
Steroids	+	+
Coumarins	-	-
Anthraquinones	-	-

(+) = presence; (-) = absence

Quantitative determination of phytoconstituents

Following a preliminary phytochemical screening of the extracts, the quantification of phytoconstituents showed that the leaf contained large amounts of alkaloids and glycosides, while the stem bark contained higher concentrations of flavonoids, tannins, saponins, phenols, and steroids (table 3).

Table 3: quantitative phytochemical constituents of leaf and stem bark (methanol extracts) of *Anogeissus leiocarpus* plant

Phytoconstituents	Leaf (mg/g extract)	Stem bark (mg/g extract)
Alkaloids	82.52±0.06^{b}	45.85±0.04^{c}
Flavonoids	48.28±0.00^{a}	72.16±0.05^{b}
Tannins	42.62±0.03^{c}	65.52±0.02^{a}
Saponins	36.55±0.04^{a}	44.25±0.02^{b}
Phenols	89.25±0.05^{b}	122.72±0.00^{a}
Steroids	31.52±0.02^{c}	55.28±0.06^{b}

Values are mean ± standard deviation of triplicates

Antibacterial activity of the leaf and stem bark (methanol extract) of *Anogeissus leiocarpus* plant

Through measurement of the average inhibition zones generated around wells, the antibacterial activity of the leaf and stem bark extracts was evaluated. As indicated by Table 4, the stem bark produced a zone of inhibitions between 10.88±0.56 – 26.24±0.00, and the leaf's activity demonstrated a broad antibacterial spectrum against uropathogens with a zone of inhibitions range between (9.00±0.65 – 16.00±1.50), as indicated by Table 5. In contrast, the standard drug, nitrofurantoin, demonstrated the broadest antibacterial spectrum against all tested organisms (24.00±0.25 – 32.00±0.52).

Table 4: effect of the leaf (methanol extracts) of *Anogeissus leiocarpus* plant against the test organisms

Isolate	Conc. (mg/ml)			Nitrofuratoin
	20	30	40	5
E. coli	9.33±0.67^{a}	11.36±2.00^{a}	14.65±0.62^{b}	26.33±0.33^{c}
K. pnuemoniae	10.56±1.00^{b}	14.00±0.00^{bc}	16.00±1.50^{c}	24.00±0.25^{a}
P. aeruginosa	10.00±0.00^{a}	10.00±0.65^{a}	13.22±0.28^{c}	24.33±0.62^{ab}
S. aureus	12.35±0.33^{d}	12.65±0.00^{d}	14.00±0.00^{a}	32.00±0.52^{d}

P. mirabilis	9.00±0.00[a]	10.00±0.00[a]	12.56±1.50[c]	28.67±1.00[b]

Values are expressed in mean±SD, values with the same superscript on the same row have no significant difference (p>0.05), n=3

Table 5: effect of the stem bark (methanol extracts) of *Anogeissus leiocarpus* plant against the test organisms

Isolate	Conc. (mg/ml)			Nitrofuratoin
	20	30	40	5
E. coli	15.33±0.67[a]	18.33±0.88[b]	23.00±0.60[c]	26.33±0.33[c]
K. pnuemoniae	11.00±1.50[d]	16.76±0.58[c]	20.65±1.15[b]	24.00±0.25[a]
P. aeruginosa	14.00±0.58[a]	14.52±0.22[a]	18.33±0.35[d]	24.33±0.62[ab]
S. aureus	12.18±0.25[b]	12.64±0.88[b]	14.24±0.00[a]	32.00±0.52[d]
P. mirabilis	10.88±0.56[a]	16.25±1.15[b]	16.82±0.25[b]	28.67±1.00[b]

Values are expressed in mean±SD, values with the same superscript on the same row have no significant difference (p>0.05), n=3

Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of methanolic extracts against the bacterial

The MIC and MBC of the Anogeissus leiocarpus plant's leaf and stem extracts were displayed in Table 6. The stem bark's MIC values varied from 0.625 to 10 mg/ml, with the lowest value of 0.625 mg/ml recorded against P. aeruginosa. The leaf extract's MIC values ranged from 2.5 to 25 mg/ml, with the lowest value of 2.5 mg/ml recorded against E. coli and P. mirabilis. On the other hand, the MBC values of the extracts from stem bark and leave range from 2.5 to 20 mg/mL and 5 to 25 mg/mL, respectively.

Table 6: the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) of the extracts in mg/ml against test bacteria

Organism	Leaf		Stem bark	
	MIC	MBC	MIC	MBC
E. coli	2.5	5	2.5	2.5
K. pnuemoniae	10	10	5	10
P. aeruginosa	10	20	0.625	2.5
S. aureus	25	25	10	20
P. mirabilis	2.5	10	1.25	10

Key: MIC- minimum inhibitory concentration, MBC- minimum bactericidal concentration.

DISCUSSION

The need for new, efficient, accessible, and reasonably priced medications to treat infectious diseases particularly in developing countries is one of the main issues facing the global healthcare system. In an effort to develop effective, secure, and widely available treatments, scientists from all over the world have kept exploring the properties of medicinal plants. It was found that the medicinal plants' phytochemicals exhibited a broad range of pharmacologic actions. However, the phytochemical components and antibacterial properties of the Anogeissus leiocarpus plant's leaf and stem bark extracts were examined and contrasted in the current study. Both extracts contain alkaloids, flavonoids, saponins, tannins, phenols, and steroids, according to the results of the phytochemical screening; only the stem bark extract contained cardiac glycosides. This result is consistent with the study conducted by other researchers, like Mubarak *et al*. (2023), Bello et al. (2020), Muhammad et al. (2022), Arbab (2014), and Mercy et al. (2017), who also mentioned these substances in combretaceae family members. Numerous studies (Mann et al., 2014; Ogbeba et al., 2017; Sale et al., 2020; Namadina et al., 2021) have reported that phytochemicals' actions against pathogenic microorganisms may involve quorum quenching, enzyme activity inhibition, bacterial membrane damage, biofilm formation, suppression of virulence factors, and inhibition of protein synthesis.

This study demonstrated the antibacterial activity of Anogeissus leiocarpus stem bark and leaf extracts against urinary infections. The test organisms produced zones of inhibition, as demonstrated by the data, indicating their susceptibility to the extracts. At all extract doses tested, the stem bark extract results in a larger zone of inhibition than the leaf extract; this finding is consistent with the total phenol and flavonoid content found in each extract. The stem bark extract was found to have a higher phenolic and flavonoid concentration than the leaf extract, indicating that the stem bark extract was more effective against the test organisms. The activities of phenolic compounds as protoplasmic poison, which can be hazardous to all types of cells, were reported by Dahiru et al. (2016). Low quantities of phenols denature proteins without coagulating them, whereas high concentrations coagulate proteins; this could account for the observed differences. Based on the findings, different concentrations of the extracts inhibited the growth of Escherichia coli, which is resistant to various antibiotics. The zones of inhibition ranged from 9.33±0.67 to 23.00±0.60. Meanwhile, Staphylococcus aureus showed only moderate activity at all concentrations of the extracts, with zones of inhibition ranging from 12.35±0.33 to 14.24±0.00. The findings corroborate the conclusion of Sale et al. (2020), who examined the in vitro antibacterial activity of the stem bark extract of Anogeissus leiocarpus on a few

bacterial pathogens. The results indicate that plant extracts are more effective against gram-negative than gram-positive organisms.

According to the study's results, stem bark extract shown strong anti-microbial growth properties with low MIC and MBC values against the test organisms. As this investigation found, high MIC and MBC values could be the consequence of a leaf extract with a similarly low efficacy. The present discovery aligns with the research conducted by Usman et al. (2020), who investigated the phytochemical and antibacterial properties of the 2020) whosus leiocarpus plant stem bark extract. When the standard antibiotic (nitrofurantoin) was used at a 5 mg/mL concentration, larger zones of inhibition were observed against all test organisms. The relative antibacterial activity of the crude extracts of the leaf and stem bark was compared, and the results showed significant differences ($p<0.05$) between the two extracts.

Conclusion

Anogeissus leiocarpus stem bark extract has a lot of promise as an antibacterial agent against the test organisms, according to the study's findings. To treat urinary tract infections brought on by these pathogens, the plant portion may thus be a good target for therapeutic development.

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