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RESEARCH ARTICLE

ANTIBACTERIAL ACTIVITY OF AQUEOUS AND ETHANOLIC ROOT EXTRACTS OF *PERICOPSIS LAXIFLORA* AGAINST MULTIDRUG-RESISTANT UROPATHOGENIC BACTERIA ISOLATED FROM PATIENTS WITH BENIGN PROSTATIC HYPERPLASIA

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Abstract

Urinary tract infections are a fairly common complication in patients with benign prostatic hyperplasia (BPH). Indeed, urinary tract obstruction and urinary retention facilitate bacterial proliferation in these patients. This study aimed to evaluate the antibacterial activity of aqueous and ethanolic extracts of *Pericopsis laxiflora* roots against multidrug-resistant bacteria isolated from the urine of patients with BPH. Antibacterial activity was assessed using the agar diffusion method (zone of inhibition) combined with double dilutions in liquid media (MIC, MBC) against four uropathogenic bacterial strains: *Klebsiella pneumoniae*, *Proteus mirabilis*, *Proteus* spp., and *Escherichia coli*. The inhibition zone diameters obtained with the ethanolic extract ranged from 11.2 mm to 16.1 mm, while those of the aqueous extract ranged from 8.1 to 10.5 mm. The minimum bacterial counts (MBCs) of the ethanolic extract were 12.50 mg/mL (*P. mirabilis*, *Proteus* spp.) and 50 mg/mL (*K. pneumoniae*, *E. coli*), respectively. The MBCs of the aqueous extract ranged from 50 mg/mL to 100 mg/mL. Both extracts exhibited bactericidal activity against all strains studied. These results suggest that *P. laxiflora* could be a potential source of new antimicrobial molecules for the treatment of urinary tract infections, which are quite common in patients with benign prostatic hyperplasia.

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Introduction:-

Urinary tract infections (UTIs) caused by bacteria are among the most common microbial infections worldwide (Flores-Mireles et al., 2015; Hsu et al., 2025). While quite common in women, UTIs also represent a major public health problem, particularly among older men. Indeed, in men, benign prostatic hyperplasia (BPH) facilitates the occurrence of UTIs (Honoré et al., 2015). This is due to urinary tract obstruction and urinary retention, which promote bacterial growth (Gandaglia et al., 2013; Oshodi et al., 2015). In these urinary tract infections, the bacteria

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most often implicated belong to the Enterobacteriaceae family, and in particular *Escherichia coli*, *Klebsiella pneumoniae* and species of the genus *Proteus* (Heising, 2010; Sokhn et al., 2020). To effectively combat urinary tract infections, several synthetic antibiotics are used. However, the effectiveness of these so-called conventional synthetic antibiotics is now compromised. This observation is linked to the increasing emergence of multidrug-resistant bacteria, particularly those producing β -lactamases (Ogbolu et al., 2018; Medugu et al., 2022). Faced with this situation, the search for new antimicrobial substances derived from medicinal plants is emerging as a promising alternative. Indeed, medicinal plants have always held a prominent place in traditional African medicine because they constitute a potential source of bioactive compounds (Kirbag et al., 2009; Shivani and Shadma, 2023). Moreover, several scientific studies based on medicinal plants have demonstrated antibacterial activity against various bacterial strains responsible for urinary tract infections (Gadisa and Tadesse, 2021). *Pericopsis laxiflora* is a plant belonging to the Fabaceae family. It is widely used in traditional medicine for the treatment of various infections (Sarfo-Antwi et al., 2021). Several scientific studies have been conducted on this plant, particularly on its leaves and trunk bark (Abou et al., 2016; Fadipe et al., 2019). The present study therefore aims to evaluate the antibacterial activity of aqueous and ethanolic extracts of *Pericopsis laxiflora* roots against multidrug-resistant uropathogenic bacteria isolated from urinary tract infections in patients with benign prostatic hyperplasia.

Materials and Methods:-

Plant Material

Roots of *P. laxiflora* were collected in January 2026 in the village of Lataha in the northern region of Côte d'Ivoire (Poro Region). This plant had been identified by botanists at the National Flores Centre, where a sample is kept. After harvesting, these roots were transported to the laboratory for analysis.

Bacterial Strains

Four potentially resistant, β -lactamase-producing uropathogenic clinical bacteria were used. These bacteria were isolated from urine samples of patients with benign prostatic hyperplasia presenting with urinary tract infections. They are *Klebsiella pneumoniae*, *Proteus mirabilis*, *Proteus spp.*, and *Escherichia coli*. They were provided by the Bacteriology Laboratory of the Regional Hospital Center (CHR) of Daloa (Côte d'Ivoire) (Table 1).

Table 1: Antibacterial profiles of the bacterial strains studied

Bacterial strains					β -lactamase activity
	Ampicillin 10 μ g	Cephotaxime 30 μ g	Nitrofurantoin 300 μ g	Nalidixicacid 30 μ g	
<i>K. pneumoniae</i>	R	R	R	R	+
<i>P. mirabilis</i>	R	R	R	R	+
<i>Proteus spp.</i>	R	R	R	R	+
<i>E. coli</i>	R	R	R	R	+

R : Resistant

Preparation of aqueous and ethanolic extracts

The roots of *P. laxiflora* were dried at room temperature in the laboratory for 30 days, protected from sunlight. After drying, they were ground using an electric grinder (RETSCH, Type AS 200, Germany) to obtain a fine powder, which was used to prepare the different extracts (aqueous and ethanolic). The aqueous extract of *P. laxiflora* roots was obtained according to the method described by Guede-Guina et al. (1997). One hundred (100) grams of root powder were macerated in 1 L of distilled water and homogenized under magnetic stirring for 24 hours at 25°C using a magnetic stirrer (RCT IKAMAG). The resulting homogenate was filtered twice through clean cloth and once through Whatman filter paper (No. 2). The volume of the resulting aqueous filtrate was first reduced using a Büchi rotary evaporator at 60°C. The remaining aqueous filtrate was then evaporated in a Med Center Venticell oven at 50°C to yield a powder, which constitutes the aqueous extract (EAq). The same procedure was performed, replacing the distilled water with ethanol, to prepare the ethanolic extract (EEth). However, in this case, the volume of the ethanolic filtrate was concentrated using the rotary evaporator at 60°C. The extracts were stored in a refrigerator for antibacterial testing.

Phytochemical analysis of extracts

The phytochemical study was conducted according to the method proposed by Toure et al. (2011). It was based on precipitation and/or staining tests in test tubes. The secondary metabolites analyzed were total phenols, flavonoids, tannins, cardiotonic glycosides, saponins, sterols, and terpenes.

Sensitivity test to extracts

This was based on the punched-well method in Mueller-Hinton agar, according to the method proposed by Ouattara et al. (2013). Petri dishes containing Mueller-Hinton agar were covered with the inoculum of each bacterium, the concentration of which was estimated at 1.5×10^6 CFU/mL. After drying the Petri dishes in an oven for 30 min at 37°C, 6 mm diameter wells were made in each one. Each well was then filled with 80 µL of a 100 mg/mL extract (aqueous and ethanolic extracts). A control well was also prepared on each Petri dish, containing 80 µL of sterile distilled water. Ampicillin (10 µg) was also used as a standard control. After 45 minutes of pre-diffusion, all Petri dishes were incubated at 37°C for 18 hours. The diameter of the growth inhibition zone around each well was measured to assess the effect of the extracts.

Determination of Minimum Inhibitory Concentrations and Bactericidal

Minimum inhibitory concentrations (MICs) were determined using the double liquid dilution method as proposed by Ouattara et al. (2013). The MIC represents the lowest concentration at which no visible bacterial growth is observed. As for the minimum bactericidal concentration (MBC), it corresponds to the lowest concentration at which less than 0.01% of the bacteria in the initial suspension survived after 24 hours. It was determined by inoculating new Mueller-Hinton culture media from the tube used to observe the MIC. Furthermore, the MBC/MIC ratio was calculated to assess the antibacterial activity of each extract. An extract is considered bactericidal if this ratio is less than or equal to 4, and bacteriostatic if it is greater than 4.

Results:-

The results of the phytochemical study showed a diversity of secondary metabolites in the extracts studied. These chemical compounds were distributed differently within the two extracts derived from the roots of *P. laxiflora*. However, it appears that the ethanolic extract is richer in phenolic compounds (total phenols, flavonoids) and then in sterols and terpenes compared to the aqueous extract (Table 2).

Table 2: Phytochemical screening of *P. laxiflora* root extracts

Secondary metabolites	Extracts	
	EEth	Eaq
Total phenols	+++	+
Flavonoids	+++	+
Catechetical Tannins	-	-
Gallic tannins	+	+
Cardiac glycosides	+	+
Alkaloids	+	+
Sterols and terpenes	++	-

EEth: ethanolic extract, EAq: aqueous extract, -: absence; +: presence

Susceptibility testing of *Pericopsis laxiflora* root extracts revealed varying inhibition zone diameters against the tested strains (Table 3). The ethanolic extract exhibited the highest inhibition zone diameters against all tested strains. With this extract, the inhibition zone diameters ranged from 11.2 mm (*K. pneumoniae*) to 16.1 mm (*P. mirabilis*). For the aqueous extract, the diameters ranged from 8.1 mm (*K. pneumoniae*) to 10.5 mm. It is clear that both extracts were more sensitive to *P. mirabilis* and *Proteus spp.* strains compared to *K. pneumoniae* and *E. coli*.

Table 3: Inhibition diameters of extracts at 100 mg/mL (mm)

Bacterial strains	Extracts		Ampicilline (10 µg)
	EEth	EAq	
<i>K. pneumoniae</i>	11,2	8,1	-
<i>P. mirabilis</i>	16,1	10,5	-
<i>Proteus spp.</i>	14,5	10,2	-
<i>E. coli</i>	12,1	8,3	-

EEth: ethanolic extract, EAq: aqueous extract, -: no inhibition

The antibacterial parameters of the studied extracts are recorded in Table 4. The results obtained corroborate those obtained with the inhibition zone diameters. Indeed, the MIC and MBC values also show greater efficacy of the ethanolic extract compared to the aqueous extract. However, the ethanolic extract was more active against *P.*

mirabilis and Proteus spp. than against *K. pneumoniae* and *E. coli*. For this ethanolic extract, the MBCs were 12.50 mg/mL (*P. mirabilis*, *Proteus* spp.) and 50 mg/mL (*K. pneumoniae*, *E. coli*), respectively. The same observation was made at the level of the CMBs of the aqueous extract which proved to be more active against strains of *P. mirabilis* (50 mg/mL), *Proteus* spp (50 mg/mL) than on *K. pneumoniae* (100 mg/mL) and *E. coli* (100 mg/mL).

Table 4: Antibacterial parameters of the extracts studied

Bacterial strains	Extracts	MIC (mg/mL)	MBC (mg/mL)	MBC/MIC
<i>K. pneumoniae</i>	EEth	50	50	1
	EAq	50	100	2
<i>P. mirabilis</i>	EEth	6,25	12,50	2
	EAq	12,50	50	4
<i>Proteus</i> spp.	EEth	12,50	12,50	1
	EAq	25	50	2
<i>E. coli</i>	EEth	50	50	1
	EAq	50	100	2

EEth: ethanolic extract, EAq: aqueous extract, MIC: minimum inhibitory concentration, MBC: minimum bactericidal concentration

Figure 1 shows a comparative action of the activities of the aqueous and ethanolic extract of *Pericopsis laxiflora* roots on the different strains studied.

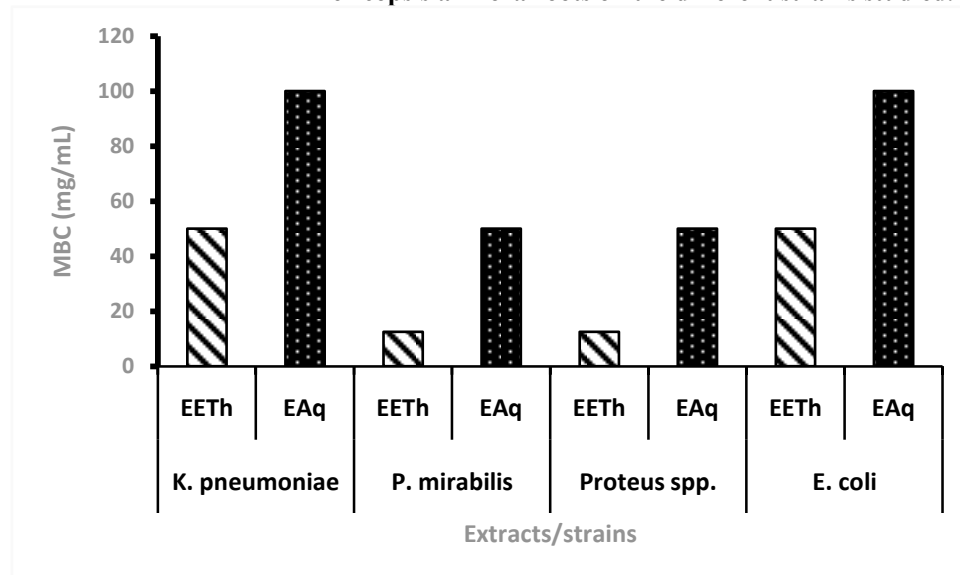


Figure 1: Comparative minimum bactericidal concentrations of the different extracts on the bacteria studied.

Discussion:-

The various chemical groups identified in this study have already been found in extracts from other organs of *P. laxiflora*. Indeed, some authors have stated that extracts from various organs of *P. laxiflora* contain these chemical compounds (Ouattara et al., 2025). Most of these groups are known for their interesting biological properties, particularly their antibacterial activity (Saad et al., 2025). The superior activity of the ethanolic extract compared to the aqueous extract could be explained by better extraction of bioactive compounds in ethanol, as observed in the phytochemical study. The low sensitivity of *K. pneumoniae* and *E. coli* strains to the studied extracts suggests the presence of higher β -lactamase activity in these strains. Indeed, some authors, in evaluating the activities of medicinal plant extracts on *K. pneumoniae* and *E. coli*, had observed a stronger resistance of these two bacterial strains compared to other uropathogenic strains (Salinas-Moreno et al., 2023; Ghaly et al., 2025).

However, the fact that the MBC/MIC ratios were all below 4 indicates the bactericidal activity of both the aqueous and ethanolic extracts against the studied strains (Musa et al., 2026). These promising results are thought to be linked to the presence of phytochemicals such as flavonoids, tannins, and alkaloids, known for their antimicrobial properties. These chemical groups were identified in the phytochemical analysis conducted during this study.

Indeed, these compounds act through various mechanisms, including alteration of the bacterial cell membrane, inhibition of protein synthesis, and inactivation of enzymes essential for bacterial metabolism (Ghédira et al., 2024; Saad et al., 2025). However, the superior activity of the ethanolic extract can be explained by the greater solubility of certain chemical groups of secondary metabolites, particularly phenolic compounds, in ethanol. Moreover, several similar observations have been reported in other scientific works on the antimicrobial activity of medicinal plant extracts against strains of urinary tract infections (Musa et al., 2026).

Conclusion:-

This study demonstrated the antibacterial activities of aqueous and ethanolic extracts of *Pericopsis laxiflora* roots against multidrug-resistant uropathogenic bacteria isolated from patients with benign prostatic hyperplasia. Both extracts showed bactericidal activity against the bacterial strains studied. However, the ethanolic extract exhibited greater activity than the aqueous extract. These results suggest that this plant could be a potential source of new antimicrobial molecules for the treatment of urinary tract infections, which are quite common in patients with benign prostatic hyperplasia.

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