Research Article

Antibacterial Effect of Bajakah Tampala Aerial Root Extract on Fish Pathogen *Proteus* spp.

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Abstract | The over use of antibiotics in aquaculture has resulted in heightened antimicrobial resistance (AMR), especially in *Proteus* spp., a zoonotic Gram-negative bacterium that presents a public health threat. A recent study in Banyuwangi, East Java, demonstrated significant antibiotic resistance among *P. mirabilis* and *P. vulgaris* isolates from African catfish (*Clarias* spp). This highlights the necessity of investigating plant-based alternatives. Bajakah Tampala (*Spatholobus littoralis* Hassk.), a traditional medicinal plant indigenous to Kalimantan, contains antibacterial compounds. This study employed the disk diffusion method with seven varying concentrations of Bajakah Tampala aerial root extracts (BTE): P1 (3.125%), P2 (6.25%), P3 (12.5%), P4 (25%), P5 (50%), a positive control K (+) with ampicillin, and a negative control K (-) consisting of aquades + CMC-Na 0.5%. *Proteus* spp. were isolated from catfish exhibiting clinical signs of superficial ulcers. The phytochemical analysis indicates that BTE comprises flavonoids, tannins, phenols, triterpenoids, and saponins. The antimicrobial tests showed that BTE inhibits both *P. vulgaris* and *P. mirabilis*. At higher concentrations (25-50%), BTE was as effective against *P. mirabilis* as ampicillin, suggesting it could be a potential alternative and further antibacterial research. However, BTE was less effective against *P. vulgaris*

Keywords: African catfish, Bajakah Tampala Extract, AMR, *Proteus* spp., Public health

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INTRODUCTION

Many countries lose a lot of money each year in aquaculture due to pathogen-induced illnesses. This is particularly apparent in countries like China, India, Vietnam, Peru, and Indonesia (FAO, 2022). Bacterial infections represent a significant constraint to aquaculture development in Indonesia, impacting both freshwater and marine fish farming (Hardi *et al.*, 2018). Gram-negative bacteria are commonly isolated from fish culture systems in many areas, including the Bangka Belitung Province (Kurniawan *et al.*, 2023) and Banjarnegara Regency in Central Java (Sarjito *et al.*, 2022). Comparable patterns have been noted in Bangladesh, where bacterial illnesses in catfish are primarily attributed to gram-negative species (Begum *et al.*, 2020).

Among pathogenic bacteria, *Proteus* spp., specifically *P. mirabilis* and *P. vulgaris*, have emerged as opportunistic threats in aquaculture. These species have been isolated from diverse aquaculture systems, including African catfish (*Clarias* sp.), which is among the most frequently cultivated fish in Indonesia (Zhai *et al.*, 2023). Recent research from East Java, Indonesia, found antibiotic-resistant *P. mirabilis* (4.05%) and *P. vulgaris* (10.81%) in African catfish (Wibawati *et al.*, 2025). These bacteria were found in fish showing signs of illness, like skin sores. These isolates demonstrated significant resistance to β-lactam antibiotics, including cefadroxil, ampicillin, penicillin, and oxacillin. The evolution of resistance in aquaculture species presents substantial threats to public health and food safety due to the possible transmission of resistant bacteria into the food chain.

The swift and extensive growth of catfish farming in Indonesia, especially via household-scale aquaculture systems, may lead to increased disease prevalence and excessive antibiotic usage (Nair *et al.*, 2025). Using antibiotics too much, or in the wrong way in aquaculture contribute considerably to the emergence of antimicrobial resistance (AMR), which has become a worldwide health issue. Projections estimate that by 2050, antimicrobial resistance (AMR) may lead to 10 million fatalities each year and generate economic losses nearing 100 trillion USD (Sakalauskienė and Radzevičienė, 2024).

In response to the escalating threat of antimicrobial resistance driven by antibiotic overuse in aquaculture, attention has increasingly shifted toward natural products with proven antibacterial potential. One such candidate is Bajakah Tampala (*Spatholobus littoralis* Hassk), a medicinal plant whose traditional use in Southeast Asia and rich phytochemical profile support its antibacterial potential (Liu *et al.*, 2022). Bajakah Tampala is a plant species widely found in Central Kalimantan but remains underutilized. In practice, it has traditionally been used by the Dayak community to treat various diseases. The therapeutic properties of this plant are presumed to be associated with the presence of diverse phenolic compounds (Weldy *et al.*, 2022). The root extract of Bajakah Tampala contains flavonoid, phenolic, and saponin components. These phytochemicals exhibit antibacterial, antiviral, and antifungal (Sianipar *et al.* 2023; Putri *et al.* 2022). Flavonoids have been widely reported to exhibit antimicrobial activity against a broad range of Gram-positive and Gram-negative bacteria, as well as yeast, with notable inhibitory effects against *Staphylococcus, Bacillus, Acinetobacter, Proteus,* and *Pseudomonas* spp (Hamid *et al.*, 2024). Phenolic compounds are also recognized for their antibacterial, anti-inflammatory, and antifungal properties and have demonstrated strong antibacterial activity, particularly against *A. hydrophila* and *Bacillus* spp (Estevinho *et al.*, 2008; Ambriz-Pérez *et al.*, 2016; Pakdee and Poowanna, 2025). Furthermore, saponins exert antibacterial effects by disrupting the outer membrane of Gram-negative bacteria by interacting with the lipid A part of lipopolysaccharides (LPS), increasing membrane permeability and compromising cell wall integrity, including in *Proteus* spp (Cankaya and Somuncuoglu, 2021). Previous studies have reported that S. littoralis exhibits various biological activities, including antioxidant, anti-inflammatory, anticancer, and notably antibacterial effects. Its extracts have shown inhibitory activity against several bacterial species, such as *Micrococcus luteus* (Yeni *et al.*, 2023), *Escherichia coli*, and *Pseudomonas aeruginosa* (Hamzah *et al.*, 2023; Setyowati *et al.*, 2024; Weldy *et al.*, 2022). Despite these promising findings, the specific bioactive constituents responsible for its antibacterial activity and their underlying mechanisms of action remain insufficiently characterized. However, few studies have tested its effectiveness against *Proteus* spp., isolates collected from aquaculture environments.

Our goal was to test the antibacterial efficacy of Bajakah Tampala aerial root extract (BTE) against *Proteus* spp. isolated from African catfish displaying superficial ulceration, in light of the escalating threat posed by *Proteus* spp. in catfish farming and the rising concern regarding antimicrobial resistance. The results are expected to contribute in the advancement of eco-friendly, plant-based antimicrobials to help make fish farming more sustainable and less dependent on manufactured antibiotics.

MATERIALS AND METHODS

Study area

This study was conducted from October to December 2024. Aerial root samples of Bajakah Tampala have been identified at the Samarinda Class 1 Agricultural Quarantine Agency in Indonesia. The extraction was conducted at the Terpadu Laboratory of the Faculty of Health, Medicine, and Life Sciences at Universitas Airlangga. The phytochemical analysis of Bajakah Tampala was carried out at the UPT Laboratorium of Herbal Materia Medica in Batu, East Java, Indonesia (Figure 1).

Figure 1: Location of study area on East Java in Indonesia.

Isolation and identification of Proteus species

This study received research ethics approval from the Research Ethics Commission of the Faculty of Veterinary Medicine, Gadjah Mada No. 115/.EC-FKH/int./2024, on October 28, 2024. We collected African catfish with red skin lesions and open sores from a fish farm pond in Banyuwangi. Samples from the liver, kidney, gut, and ulcerated surfaces (skin and muscle ulcers) of the catfish were isolated and identified as *Proteus* spp. The identification of *Proteus* species were conducted with MacConkey Agar media (Oxoid), gram staining, Sulfate Indole Motility (SIM) test, oxidase test, MR-VP test, citrate test, and Triple Sugar Iron Agar (TSIA) test (Anifowose *et al.*, 2024). In Rimler-Shotts Medium Base (Himedia M576), the presumed colonies of *Proteus* species have a golden coloration with black cores.

Bajakah tampala aerial root extract (BTE) extraction

The aerial roots of Bajakah Tampala, obtained from East Kalimantan Province, were segmented into small pieces and subsequently sun-dried for approximately five days. Thereafter, it is processed into a powder. Eight hundred grams of Bajakah Tampala aerial root powder were mixed with 96% ethanol solvent in a 1:5 weight-to-volume ratio. Maceration occurs for 72 hours at room temperature, protected from sunlight, with periodic stirring. The results of maceration are separated using filtration equipment. We then evaporated the liquid using a rotary evaporator at 50°C and this gave us 25.6 g of a thick paste (100% concentration). The stock solution was used to prepare test solutions at concentrations of 3.125%, 6.25%, 12.5%, 25%, and 50% (w/v) through serial dilution, using the equation $V_1 \times C_1 = V_2 \times C_2$, where V represents volume and C indicates concentration. The concentration units mean grams of crude extract per 100 ml of solvent, with the final volume of each test solution adjusted to 20 mL. We used a 0.5% CMC-Na solution to dilute the extract. This helped suspend the extract evenly in the water.

Phytochemical test bajakah tampala aerial root extract (BTE)

A test of the phytochemical Bajakah Tampala aerial root extract (BTE) was performed to discover its main secondary metabolites, commonly linked to antibacterial action. The tested substances included flavonoids, alkaloids, tannins, phenols, steroids, triterpenoids, and saponins. These bioactive chemicals are recognized for their varied biological actions, including membrane disruption, enzyme inhibition, and interference of bacterial metabolism. The identification of these phytochemicals was performed in accordance with the standardized protocols specified in the Indonesian Herbal Pharmacopeia (Ministry of Health of the Republic of Indonesia, 2017). Knowing what's in the extract is key to linking its antimicrobial efficacy to the presence of certain active compounds, thereby providing a scientific foundation for its future advancement as a plant-derived antibacterial drug.

Test of BTE antibacterial efficacy

Two gram-negative bacterial species, *P. vulgaris* and *P. mirabilis*, with one isolate from each species, were used to assess the antibacterial activity of BTE. We used the disk diffusion method for antimicrobial screening in Mueller Hinton Agar (MHA) media (Oxoid) (CLSI, 2020). The disk diffusion assay was performed with four replicates (N= 4) using the identical isolate. The utilized BTE concentrations are 3.125%, 6.25%, 12.5%, 25%, and 50%. 20 µl of each BTE concentration was dispensed using a micropipette onto a blank disk (Oxoid) and allowed to absorb completely for 15 minutes. In this research, a 0.5 McFarland standard was used to set the concentration of the bacterial suspension before the disk diffusion test. The turbidity of the bacterial solution was compared to the McFarland standard to make sure that the inoculum density was within 1.5×10^8 CFU/mL. Next, 100 µl of the bacterial suspension was taken out using a micropipette and subsequently inoculated onto MHA, then left for 20 minutes. Paper discs filled with BTE, based on concentration, were placed on the MHA media surface using mechanical tweezers and incubated at 37 °C for 24 hours. For comparison, we used ampicillin discs (10 µg) as a positive control, since it's a common antibiotic in fish farming and Aquades + CMC-Na 0.5% as a negative control. Furthermore, the diameter measurements of the inhibitory zone post-incubation were conducted by one researcher using a digital caliper with an accuracy of 0.01 mm, and the findings were documented in millimeters (mm).

Data analysis

The data in this study was analyzed using SPSS version 25. A two-way ANOVA was employed to assess its significance. Differences were considered significant if $P < 0.05$.

RESULTS

Result of identification of *Proteus* species from African catfish

Isolation results confirmed the presence of *P. mirabilis* and *P. vulgaris* in multiple organs, including the liver, kidney, gut and skin ulcers of symptomatic African catfish (Table 1).

Table 1: Results of identification of *P. vulgaris* and *P. mirabilis* bacteria in African catfish samples.

Test	Result	
	P. vulgaris	***P. mirabilis***
MCA	Colorless	Colorless
Gram	Gram-negative	Gram-negative
Morphology	Long rods	Long rods
KOH 3%	-	-
Oxidase	+	-
TSIA	AC/AC/+/+	AL/AC/+/+
Produce H2S	+	+
Indole	+	-
Motility	+	+
SCA	-	+/-
MR	+	+
VP	-	-
RS Agar	Yellow colonies with black centers	Yellow colonies with black centers

Note: (+) indicates a positive result, (-) indicates a negative result, AC: acid and AL: alkali

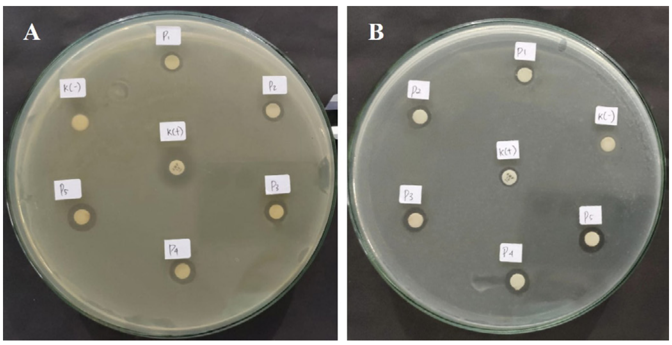

Figure 2: Antibacterial activity of Bajakah Tampala aerial root extract (BTE) against *Proteus* species.

Phytochemical test of bajakah tampala aerial root extract

Bajakah Tampala aerial root extract contains flavonoid, tanin, fenol, triterpenoid and saponin as summarised in (Table 2).

Result of BTE antibacterial efficacy

Figure 2 shows the inhibition zones produced by different concentrations of BTE, a positive control (ampicillin, K+), and a negative control (K-) on a Mueller-Hinton agar plate inoculated with (A) *Proteus* vulgaris and (B) *Proteus* mirabilis. The numbers 1-5 correspond to BTE concentrations of 3.125%, 6.25%, 12.5%, 25%, and 50%, respectively.

Table 2: Phytochemical test results in BTE.

Phytochemical compounds	Test result	
	Qualitative	**Quantitative**
Flavonoid	+	9,1047 mg Q/g
Alkaloid	-	-
Tannin	+	26,2745 mg ET/g
Phenol	+	8,2152 mg GA/g
Steroid	-	-
Triterpenoid	+	N/A
Saponin	+	N/A

Note: (+) indicating a positive result, (-) indicating a negative result, and N/A indicating not quantified

The interaction between two independent variables, extract concentration and bacterial species, is summarized in (Table 3). According to the findings presented in Table 4 and (Figure 2), the negative control group (K-) exhibited no inhibitory zone in the two gram-negative bacterial samples. It demonstrated significant differences with the BTE treatment groups (P1, P2, P3, P4, and P5) and the positive control (K+). We saw clear zones where bacteria couldn't grow in P1, P2, P3, P4, P5, and K+. The results indicated that K+ did not differ significantly from P3 (BTE 12.5%) for *P. mirabilis*. In contrast, ampicillin's effect on *P. vulgaris* was different from all the extract treatments.

Table 3: Result of two-way ANOVA on the interaction of BTE and bacterial species on inhibition zone diameter.

Source of variation	df	F value	P value
Treatment BTE	6	854.288	< 0,001
Bacteria	1	16.695	< 0,001
Treatment x Bacteria	6	8.901	< 0,001
Error	42	-	-

Note: Data were analyzed using two-way analysis of variance (ANOVA). Treatment BTE and bacteria type were considered as fixed factors. The interaction term (treatment BTE × bacteria) represents the combined effect of both factors on inhibition zone diameter. Differences were considered statistically significant at $p < 0.05$.

Links Researchers

DISCUSSION

P. mirabilis was identified on ulcerated surfaces, including skin and muscular ulcers, while *P. vulgaris* was detected in the intestines, liver, and ulcerated surfaces of African catfish, as shown in the identification results presented in (Table 1). This is similar to research of Zhai *et al.* (2023), on yellow catfish (*Pelteobagrus fulvidraco*) and channel catfish (*Ictalurus punctatus*), identified numerous common pathogenic bacteria, including *Aeromonas* spp., *Vibrio* spp., *Moraxella* spp., and *Proteus* spp., from the ulcerated surfaces of these catfish. Furthermore, these diverse pathogens may be transmitted from fish to people (Farzadnia *et al.* 2020). *P. mirabilis* and *P. vulgaris* are *Proteus* species that are commonly involved in urinary tract infections in humans (Schaffer and Pearson, 2015). *Proteus* infections will continue to pose a health challenge in the foreseeable future, given the rising life duration of humans, leading to a greater population of elderly individuals with potential comorbidities who are more vulnerable.

The Bajakah Tampala plant is a member of the Leguminosae family. In the Dayak population of Central Kalimantan, Indonesia, this plant is regarded as a traditional treatment for pain and diarrhea, alleviating body lumps and decreasing uric acid levels (Sianipar *et al.* 2023). Quantitative phytochemical analysis of the BTE has revealed the presence of various significant secondary metabolites (Table 2). The phytochemical analysis revealed that tannins were the most abundant secondary metabolites in BTE at 26.2745 mg ellagic acid equivalent per gram (mg ET/g). This finding is consistent with previous reports (Fitriani *et al.*, 2020), which also found that the tannin compound in BTE exhibits the highest concentration at 46.46 mg/g compared to other compounds. Other quantitative analyses indicate that the extract contains flavonoids at a concentration of 9.1047 mg quercetin equivalent per gram (mg Q/g), and phenolic compounds at 8.2152 mg gallic acid equivalent per gram (mg GA/g). Triterpenoids and saponins were detected, although their concentrations were not quantified in the study. These findings suggest that the detected phytochemicals may contribute to the observed antibacterial activity. Collectively, such phytochemicals are widely recognized for their contribution to the pharmacological potential of plants, particularly with respect to antibacterial effects. Consistent with the present findings, previous studies have reported the presence of flavonoids, saponins, steroids, terpenoids, tannins, and phenolic compounds in the phytochemical composition of Bajakah Tampala (Iskandar *et al.* 2022; Rahminiwati *et al.* 2023).

The positive control employed in this study was the antibiotic ampicillin. The diameter of the inhibition zone for the positive control falls within the resistant group (≤13 mm) as shown in (Figure 2) and showed no significant difference from P3. This indicates that the efficacy of ampicillin, which exhibits resistance, is comparable to the P3 treatment group. Ampicillin is a broad-spectrum semi-synthetic antibiotic derived from penicillin, effective against both gram-positive and gram-negative bacteria. Ampicillin acts as an antibiotic by inhibiting bacterial growth and reproduction through the disruption of cell wall formation, leading to cell lysis and subsequent death (Zhang *et al.*, 2023).

Consequently, there is a necessity for alternative antibiotics in the form of eco-friendly, cost-effective antibacterial chemicals that can be readily sourced from nature. One aspect of biodiversity utilized in traditional medicine is the BTE.

The difference in susceptibility of the two Gram-negative bacteria to BTE may be linked to variations in bacterial cell wall composition and adaptive resistance mechanisms. Previous studies have reported that *P. vulgaris* may exhibit intrinsic resistance-associated features, such as efflux systems, biofilm formation, and reduced membrane permeability, which can limit antimicrobial penetration (Sorenson *et al.* 2025; Baron and Rolain, 2018). In contrast, *P. mirabilis* exhibited heightened susceptibility to BTE, which may may be due to intrinsic permeability barriers or other nonspecific variables. These findings correspond with the research conducted by Rathi *et al.* (2020), which indicated that bacterial resistance patterns markedly affect the efficacy of phytochemical-based therapies. While such mechanisms were not directly assessed in the present study, they may partly explain the reduced susceptibility observed.

Those bacteria were taken from different organs (*P. vulgaris* from the liver and *P. mirabilis* from skin lesions) and the susceptibility of the bacteria could be affected by the origin of the isolates, as bacteria from different anatomical sites may represent distinct strains with varying resistance profiles. For example, Klebsiella pneumoniae strains taken from urine were more resistant to antibiotics and had more virulence characteristics than those taken from blood or respiratory sources, indicating site-specific adaptations (Ballén *et al.*, 2021). Similarly, *Neisseria gonorrhoeae* infections in people with infections at many places showed that 14.6% of the cases had various strains at different sites, each with its own unique antibiotic susceptibility profile (Miari *et al.*, 2025).

The efficacy of BTE at lower concentrations, starting at 3.125%, demonstrates the significant antibacterial strength of its phytochemical components. The most substantial average inhibitory zones have been observed in *P. mirabilis*, especially at BTE doses of 25% and 50%. The bacteria exhibited a consistent dose-dependent response, with a notable increase in inhibitory zone widths corresponding to the rising concentration of BTE (Table 4). Natural compounds, such as tannins, flavonoids, and saponins, exhibit several modes of action, including protein precipitation, enzyme inhibition, and membrane disruption (Mishra *et al*., 2023). The use of bioactive compounds in aquaculture can provide an alternative approach to decrease reliance on synthetic antibiotics and mitigate the danger of antimicrobial resistance spread (Naiel *et al*., 2023; Rafi, 2025). Recent research indicate that plant-based antimicrobials reduce the danger of residue growth in aquatic products and enhance the sustainability of aquaculture systems (Kılıç and Gültekin, 2024; Dadras *et al*., 2023).

P. vulgaris demonstrated a reaction pattern similar to that of *P. mirabilis*. A zone of inhibition was observed at all BTE concentrations, with zone values increasing alongside rising BTE concentrations. Nonetheless, elevating the extract concentration from 12.5% to 50% did not result in a statistically significant change in the inhibition diameter, indicating that the antibacterial effect may have reached a saturation threshold. This findings may reflect a concentration-dependent saturation effect in *P. vulgaris*, indicating that increasing extract concentration does not proportionally enhance antibacterial activity. This observation raises the hypothesis that *P. vulgaris* may possess physiological features that constrain intracellular phytochemical accumulation at higher extract concentrations. This resistance may be associated by *P. vulgaris*'s capacity to form biofilms or modify its membrane protein structure, thereby diminishing the interaction between antibacterial drugs and essential cellular targets (Kwiecinska-Pirog *et al*., 2016). However, these mechanisms were not evaluated in the present study and warrant further investigation.

Studies indicate that extracts of Bajakah Tampala properly inhibit the proliferation of several bacteria, including Pseudomonas aeruginosa and *Bacillus subtilis*, therefore serving as a viable alternative treatment for mixed infections. A study indicated that 100% and 75% concentrations of Bajakah wood extract resulted in inhibition zones of 5.05 mm and 3.84 mm, respectively, against Pseudomonas aeruginosa, but the positive control (NaOCl) exhibited a greater inhibition zone of 16.14 mm (Permatasari *et al*., 2024). The concentration of flavonoids in red Bajakah Tampala roots enhances antibacterial activity, evidenced by an increase in the inhibition zone from 6.23 mm to 7.18 mm as flavonoid concentration rises from 10 ppm to 30 ppm (Hafifah and Suparno, 2023). The presence of alkaloids and terpenoids in bajakah is linked to its antibacterial effectiveness against *Escherichia coli*, with a minimum inhibitory concentration determined to be 6.25% (Lismana *et al*., 2022).

The interaction between the bacterial isolates and the concentration variable of BTE followed a typical nonlinear dose response curve in most species, where higher concentrations produced significantly greater inhibitory effects. Table 3 showed that conncentration of BTE, bacteria type, and their interaction had a significant effect on inhibition zone diameter ($p < 0.001$), indicating differences in antibacterial responses across each treatment BTE-bacteria combination. Each species exhibits distinct sensitivity and response patterns to changes in treatment BTE concentration, which may be associated with differences in physiological characteristics and adaptive capacity. The high F-value observed for the treatment BTE factor indicates that treatment was the dominant factor influencing the response variable, followed by bacterial species and their interaction. This interaction suggests that the antimicrobial activity of BTE is strongly dependent on compound availability and bacterial susceptibility.

The presence of tannins, flavonoids, and triterpenoids in the extract may partially explain the antibacterial activity observed. These phytochemical groups have been documented to exhibit antibacterial properties via mechanisms including disruption of protein synthesis, inhibition of nucleic acid biosynthesis, and alteration of membrane permeability (Bouarab *et al*., 2019). However, given that only a crude extract was evaluated, the individual roles of these compounds and any potential synergistic interactions remain unclear. In addition, the predominant of a particular phytochemical class does not necessarily indicate a proportionally greater contribution to the overall antibacterial effect. While tannins represented the predominant phytochemical class in BTE (Table 2), the present experimental design did not allow a direct correlation analysis between phytochemical abundance and antibacterial efficacy (Table 4), as antibacterial testing was performed using crude extracts. Consequently, the contribution of individual phytochemical classes cannot be quantitatively distinguished, and the antibacterial activity is more appropriately interpreted as the combined effect of multiple phytochemicals rather than the action of a single dominant compound. Furthermore, as no mechanistic assays were performed, the mode of bacterial inhibition cannot be directly inferred from the present data. Future studies with fractionated extracts and specific antibacterial assays will help clarify the role of different phytochemical classes and the antibacterial mechanism of BTE. This is required compared with antibiotics that remain highly effective against *Proteus* species, which will strengthen the evaluation of the extracts antibacterial efficacy.

Table 4: Calculation results of the average diameter of the antibacterial inhibition zone *P. vulgaris* and *P. mirabilis*.

Group	N	Inhibition zone ($\dot{X}$ ± SD)	
		P. vulgaris	*P. mirabilis*
P1	4	7.06^{b} ± 0.075	6.92^{b} ± 0.086
P2	4	7.37^{bc} ± 0.259	7.21^{bc} ± 0.110
P3	4	7.82^{cd} ± 0.347	7.50^{cd} ± 0.212
P4	4	8.05^{d} ± 0.387	7.87^{d} ± 0.462
P5	4	8.11^{d} ± 0.349	8.35^{e} ± 0.248
K+	4	9.00^{e} ± 0.770	7.38^{c} ± 0.532
K-	4	00.00^{a} ± 0.000	00.00^{a} ± 0.000

Note: Different superscripts ($^{a\ b\ c\ d\ e}$) in the same column show significant differences (p<0.05). P1: Bajakah tampala exstract (BTE) 3.125%, P2: BTE 6.25%, P3: BTE 12.5%, P4: BTE 25%, and P5: BTE 50%, K (+): Ampicilin antibiotic, K (-): Aquades+CMC-Na 0.5%.

CONCLUSION

The aerial root extract of Bajakah Tampala (BTE) shows selective antibacterial activity, inhibiting *Proteus* mirabilis more effectively than *P. vulgaris in vitro*. Its efficacy against ampicillin-resistant *P. mirabilis* at higher concentrations (25-50%) suggests it contains bioactive compounds worth investigating further. However, its limited effect on *P. vulgaris* and the use of a crude extract highlight the need for future studies focused on isolating the active principles and understanding their specific mechanisms of action against different *Proteus* species, which could involve biological replicates that can be generalized to the whole species. This work provides a foundational step toward developing targeted, plant-based interventions for aquaculture.

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NOVELTY STATEMENT

The novelty of this study is that antibacterial activity of Bajakah Tampala extract against resistant Proteus spp. from African catfish have been directly evaluated and not been explored adequately in the recent decade. This study is different from others that focus on antioxidant, anti-inflammatory or antibiofilm properties against bacteria such as *Pseudomonas aeruginosa*. The efficacy was meticulously assessed at various doses by a disc diffusion experiment conducted. Initial direct investigation of *Proteus* spp.

AUTHOR'S CONTRIBUTION

YC and PAW: conceptualized the study, initiated the research, YC, DA, DRR and NR: performed the laboratory procedures and participated in data interpretation. NR, PAW and DKW: provided supervision, methodological validation, and critical review of the manuscript. YC and PAW: Writing-original draft. DKW and CMN: writing-review and editing. CMN: supported field sample collection and contributed contextual input related to animal and public health. All authors have read and approved the final manuscript.

Generative AI and AI-assisted technology statement

Generative AI and AI-assisted technologies were utilized for grammar and style checking, as well as to refine author-written paragraphs for improved clarity. The authors thoroughly reviewed, verified, and edited all AI-generated output to ensure the accuracy and integrity of the scientific content.

Conflict of interest

The authors have declared that there is no conflict of interests regarding the publication of this article.

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