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Bioactive Potential of *Rumex pictus*: Phytochemical Constituents, Antioxidant, and Antimicrobial Properties

Alaa T. Elghazy [1,*], ***Ashraf A. El-Said*** [1], ***Yasser A. El-Amier*** [1]

[1]*Botany Department, Faculty of Science, Mansoura University, Mansoura - 35516, Egypt*

**** Correspondence to:*** *yasran@mans.edu.eg*

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Abstract:*Rumex pictus* Forssk., a plant traditionally used in North African and Middle Eastern medicine, is still little studied for its chemical composition and biological activities. The present study was designed to investigate the phytochemical composition, antioxidant activity, and antimicrobial potential of the methanolic extract obtained from the aerial parts of this plant. Qualitative phytochemical screening revealed the presence of a wide spectrum of bioactive secondary metabolites, with flavonoids, phenols, glycosides, and anthraquinones occurring in high concentrations, while tannins and steroids were detected at moderate levels. The antioxidant activity, assessed using the DPPH radical scavenging assay, demonstrated a clear dose-dependent response, with an IC_{50} value of 29.77 mg/mL. In contrast, the standard antioxidant, vitamin C, showed significantly higher activity, with an IC_{50} value of 7.42 mg/mL, achieving 84.38% inhibition at only 20 mg/mL.. Antimicrobial evaluation, carried out through the agar well diffusion method, confirmed that the methanolic extract possesses broad-spectrum antibacterial effects. The extract inhibited the growth of both Gram-positive and Gram-negative bacteria, including *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, and *Salmonella typhi*. While the inhibitory effects were weaker than those of standard antibiotics, the extract displayed pronounced activity against Gram-positive strains, particularly *S. aureus* and *B. cereus*. These findings demonstrate that *R. pictus* is a valuable reservoir of bioactive compounds with relevant antioxidant and antimicrobial properties. The results support its traditional medicinal uses and indicate its potential as a natural source of therapeutic agents against oxidative stress and microbial infections.

keywords: Rumex pictus; Desert; DPPH, pathogenic bacteria, phytochemical.

1. Introduction

Therapeutic plants have played a pivotal role in human health and illness management for centuries. Traditional medicine across cultures has relied extensively on natural products derived from herbs as a primary source of therapy, and even today, phytochemicals continue to contribute significantly to modern pharmacology [1]. The increasing prevalence of antimicrobial resistance and the need for safe antioxidant agents have renewed global scientific interest in medicinal plants as reservoirs of bioactive compounds. Among these, species belonging to the genus *Rumex* (Polygonaceae) have attracted attention due to their wide distribution, ethnomedicinal applications, and diverse phytochemical composition [2].

The *Rumex* genus, commonly known as dock or sorrel, comprises more than 200 species distributed worldwide, with many found in temperate and subtropical regions. Several species are well documented in ethnopharmacology for the treatment of skin disorders, digestive ailments, infections, and inflammatory conditions [3]. Phytochemical investigations of the genus reveal the presence of bioactive secondary metabolites such as anthraquinones, flavonoids, phenolic acids, tannins, and naphthalenes [4]. These metabolites are associated with a broad spectrum of biological activities including

antimicrobial, antioxidant, anti-inflammatory, and cytotoxic effects.

Rumex pictus Forssk., native to parts of North Africa and the Middle East, remains relatively underexplored compared to its congeners. Ethnobotanical reports suggest its traditional use in managing infections and inflammatory conditions [5]. However, comprehensive scientific investigations into its phytochemical profile and bioactivities are limited. Recent studies by El-Shazly et al. [6] and Hussein et al. [7] have demonstrated that methanolic extracts of *R. pictus* contain anthraquinones and flavonoids, compounds associated with antimicrobial and antioxidant properties. Despite these promising results, available research is fragmentary, and the plant's full therapeutic potential is yet to be elucidated.

One of the most pressing challenges in global health is the increasing incidence of antimicrobial resistance. The World Health Organization has identified resistant pathogens such as *Klebsiella pneumoniae*, *Escherichia coli*, and *Staphylococcus aureus* as major threats to human health [8]. Plant-derived antimicrobials, particularly polyphenols and flavonoids, are known to disrupt microbial membranes, inhibit enzyme activity, and prevent biofilm formation [9]. Given the evidence that several *Rumex* species possess antimicrobial activity, *R. pictus* may represent a valuable natural source of novel antimicrobials, potentially contributing to the fight against multidrug-resistant pathogens.

Beyond antimicrobial resistance, oxidative stress is now recognized as a major contributor to the development of chronic illnesses such as cardiovascular disease, diabetes, cancer, and neurodegenerative disorders. By neutralizing reactive oxygen species (ROS), antioxidants protect cells from oxidative injury and play a vital role in slowing or preventing disease progression [10]. Natural antioxidants from plants, especially flavonoids and phenolic acids, have gained significant attention due to their safety and multiple health-promoting effects [11]. Reports on *Rumex* species indicate strong antioxidant potential, as seen in *R. vesicarius* and *R. algeriensis* [12,13]. However, the antioxidant potential of *R. pictus* remains poorly characterized, creating a gap in literature.

Therefore, the present study aims to investigate the bioactive potential of *Rumex pictus* by conducting qualitative phytochemical screening and evaluating its antioxidant and antimicrobial properties.

2. Materials and Methods

2.1. Plant collection

Fresh aerial parts of *Rumex pictus* Forssk. were collected during the flowering season in 2024 from Deltaic coast, Egypt. The plant was identified and authenticated based on the descriptions in Boulos [14], and a voucher specimen (Mans.018016016005) was prepared and deposited in the herbarium of the Department of Botany, Faculty of Science, [Mansoura University], for future reference. The collected material was thoroughly cleaned to remove dust and debris, air-dried under shade at room temperature for two weeks, and then ground into a fine powder using an electric mill. The powdered material was stored in airtight containers at room temperature until further phytochemical and biological analyses were carried out.

2.2. Qualitative phytochemical screening

Preliminary phytochemical screening of the powdered aerial parts of *Rumex pictus* was carried out to identify the presence of major classes of secondary metabolites following the standard procedures described by Harborne [15] and Trease & Evans [16], with slight modifications. Alkaloids were tested using Mayer's and Dragendorff's reagents, where the formation of creamy white or reddish-brown precipitates confirmed their presence. Flavonoids were detected by the Shinoda test, indicated by the development of pink or red coloration upon the addition of magnesium turnings and concentrated hydrochloric acid. Phenols and tannins were assessed by the ferric chloride test, producing blue-black or greenish coloration, respectively.

Saponins were identified by the frothing test, where persistent foam after vigorous shaking with water indicated their presence. Glycosides were determined by the Keller–Killiani test, in which the formation of a reddish-brown ring at the interface confirmed cardiac glycosides.

Terpenoids were screened using the Salkowski test, where a reddish-brown coloration at the interface suggested their presence, while steroids were evaluated by Liebermann–Burchard's test, giving a green or blue coloration. Finally, anthraquinones were detected by Borntrager's test, indicated by the appearance of a pink to red coloration after treatment with ammonia. All tests were performed in triplicate, and the results were recorded qualitatively as either present or absent)

2.3. Antioxidant Activity

The antioxidant activity of the methanolic extract of *Rumex pictus* was determined using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay as described by Miguel [17], with slight modifications. Briefly, a 0.1 mM solution of DPPH in methanol was prepared, and 1 mL of this solution was mixed with 1 mL of the plant extract at different concentrations (ranging from 50, 100, 200, 300, 400 and 500 mg/mL). The mixture was vigorously shaken and incubated in the dark at room temperature for 30 minutes to allow the reaction to occur. The decrease in absorbance was measured at 517 nm using a UV–Vis spectrophotometer, and methanol was used as a blank. Ascorbic acid was used as a positive control for comparison. The percentage inhibition of DPPH radicals was calculated using the following equation:

$$\% \text{ Inhibition} = [(A0 - A1)/A0] \times 100$$

where A0 is the absorbance of the control (DPPH solution without extract) and A1 is the absorbance in the presence of the extract. The IC_{50} value, defined as the concentration of extract required to scavenge 50% of DPPH radicals, was determined from the dose–response curve. All experiments were performed in triplicate, and results were expressed as mean ± standard deviation.

2.4. Antibacterial activity

2.4.1. Tested organisms

Gram-negative bacteria (*Escherichia coli, Klebsiella pneumonie* and *Salmonella typhi*) and Gram-positive bacteria (*Bacillus cereus, Enterococcus faecalis, Staphylococcus aureus* and *Staphylococcus haemolytic*).

2.4.2. Antibacterial assay

The antibacterial activity of the methanolic extract of *Rumex pictus* was assessed using the agar well diffusion method as described by Perez [18], with slight modifications. Clinical strains of Gram-positive bacteria and Gram-negative bacteria were used as test organisms. Fresh bacterial cultures were adjusted to 0.5 McFarland standard (approximately 1×10^8 CFU/mL) and uniformly spread on the surface of Mueller–Hinton agar plates using sterile cotton swabs. Wells of 6 mm diameter were aseptically punched into the agar and filled with 100 µL of the plant extract at different concentrations. Plates were incubated at 37 °C for 24 hours, and the antibacterial activity was evaluated by measuring the diameter of the inhibition zones around each well. Methanol served as a negative control, while standard antibiotics such as ampicillin, penicillin, chloramphenical and gentamicin were used as positive controls for comparison. All experiments were conducted in triplicate, and the results were expressed as mean ± standard deviation.

3. Results and Discussion

3.1. Qualitative phytochemical screening

The qualitative phytochemical screening of *Rumex pictus* revealed the presence of a diverse array of bioactive secondary metabolites, albeit in varying intensities. Among these, flavonoids, phenols, glycosides, and anthraquinones were strongly detected (+++), indicating that these compounds may constitute the major phytochemical groups in this species. Tannins and steroids were moderately present (++), while alkaloids, saponins, and terpenes were detected in relatively lower concentrations (+) .

The abundance of flavonoids and phenols suggests a strong antioxidant potential of *R. pictus*, as these compounds are well known for their ability to scavenge free radicals, chelate metal ions, and prevent oxidative stress–related damage [19]. This correlates with the traditional use of *Rumex* species in herbal medicine for their protective effects against inflammation and chronic diseases. Similarly, the rich presence of anthraquinones is noteworthy, as these compounds are characteristic of the *Rumex* genus and have been reported to exhibit significant

antimicrobial, laxative, and anticancer activities [20]. The high detection of glycosides further supports the medicinal relevance of this plant, since glycosidic compounds often contribute to cardioprotective, antimicrobial, and immunomodulatory effects [21].

The moderate presence of tannins and steroids also enhances the pharmacological potential of *R. pictus*. Tannins are known to possess antimicrobial, astringent, and antioxidant properties, which may contribute to the antibacterial activity observed in many *Rumex* extracts [22]. Steroids, on the other hand, play a role in maintaining membrane stability and have been associated with anti-inflammatory and cytotoxic activities [23]. The low presence of alkaloids, saponins, and terpenes does not diminish their importance, as even in smaller quantities, these compounds can exert significant biological effects. Alkaloids are widely recognized for their antimicrobial, analgesic, and antimalarial properties [24], while saponins display surface-active properties that enhance antimicrobial efficacy and contribute to cholesterol-lowering activity [25]. Terpenes, though weakly present, are valuable for their broad-spectrum antimicrobial, anticancer, and anti-inflammatory effects [26].

Taken together, the phytochemical profile of *R. pictus* demonstrates a synergistic presence of compounds with strong antioxidant and antimicrobial potential, which supports its ethnomedicinal applications and highlights its promise as a source of natural bioactive agents. The predominance of flavonoids, phenols, glycosides, and anthraquinones may explain the plant's strong radical scavenging and antibacterial activity observed in subsequent assays. These findings align with earlier reports on other *Rumex* species, which similarly emphasize the rich presence of phenolic and anthraquinone derivatives as the basis of their therapeutic value [27,28].

3.2. Antioxidant Activity

The DPPH radical scavenging assay demonstrated that the methanolic extract of *Rumex pictus* exhibited dose-dependent antioxidant activity, with scavenging percentages ranging from 9.58% at 50 mg/mL to 74.15% at 500 mg/mL. The extract displayed an IC_{50} value of 29.77 mg/mL, indicating moderate free radical scavenging potential. In contrast, the standard antioxidant, vitamin C, showed significantly higher activity, with an IC_{50} value of 7.42 mg/mL, achieving 84.38% inhibition at only 20 mg/mL. These findings highlight that while *R. pictus* is less potent than vitamin C, it nonetheless contains substantial radical scavenging compounds that may contribute to its pharmacological properties.

The relatively strong activity of *R. pictus* can be attributed to its high content of flavonoids and phenolic compounds, as revealed by phytochemical screening. These groups of secondary metabolites are known for their hydrogen-donating ability and capacity to neutralize free radicals, thereby preventing oxidative stress and cellular damage [19]. The scavenging activity observed at higher extract concentrations (≥300 mg/mL) suggests a cumulative effect of multiple bioactive constituents, including phenols, flavonoids, anthraquinones, and glycosides, which may act synergistically to enhance antioxidant potential.

Table 1. Qualitative phytochemical analysis of some wild plants collected from the coastal desert.

Screening test	Rumex pictus
Alkaloids	+
Flavonoids	+++
Phenols	+++
Saponins	+
Tannins	++
Steroids	++
Glycosides	+++
Anthraquinones	+++
Terpenes	+

- = absent/trace, + = low, ++ = moderate, +++ = high

Although the plant extract was less efficient than the pure standard (vitamin C), its activity is noteworthy considering that crude extracts contain a complex mixture of compounds, some of which may be present in relatively low concentrations. Moreover, the IC_{50} value indicates that *R. pictus* possesses significant antioxidant capacity compared with other reported medicinal plants, particularly within the genus *Rumex*, where species such as *R. crispus* and *R. dentatus* have also shown moderate-to-strong antioxidant activity [27,29].

Overall, these results suggest that *Rumex pictus* could serve as a promising natural source of antioxidants, which may be beneficial in preventing oxidative stress–related disorders such as cardiovascular diseases, diabetes, and cancer. Further fractionation and isolation of its active constituents may enhance its antioxidant potency and clarify the specific compounds responsible for the observed activity.

3.3. Antibacterial activity

The methanolic extract of *Rumex pictus* exhibited broad-spectrum antibacterial activity against both Gram-negative and Gram-positive bacteria, although its inhibitory effects were generally lower than those of the tested standard antibiotics. The inhibition zones produced by the extract ranged from 11 mm (against *Klebsiella pneumoniae*) to 18 mm (against *Bacillus cereus*), indicating variable sensitivity among the tested organisms. Among Gram-negative bacteria, *Salmonella typhi* (15 mm) and *Escherichia coli* (14 mm) were the most susceptible, whereas *K. pneumoniae* displayed the lowest sensitivity (11 mm). In the case of Gram-positive strains, *B. cereus* showed the highest inhibition zone (18 mm), followed by *Staphylococcus aureus* (17 mm), while *Staphylococcus haemolyticus* and *Enterococcus faecalis* exhibited relatively moderate inhibition (12 and 13 mm, respectively).

Table 2. Scavenging activity percentage of DPPH and the IC_{50} values by MeOH extract of *Rumex pictus* and vitamin C as standard.

Plant species	Concentration (mg/ml)	Scavenging activity (%)	IC_{50} (mg/ml)
Rumex pictus	500	74.15±2.34	**29.77**
	400	66.69±2.19	
	300	52.88±1.72	
	200	42.13±1.29	
	100	20.75±0.81	
	50	9.58±0.44	
Vitamin C	20	84.38±2.92	**7.42**
	15	71.70±2.07	
	10	65.03±1.85	
	5	56.36±1.09	
	2.5	32.50±0.81	

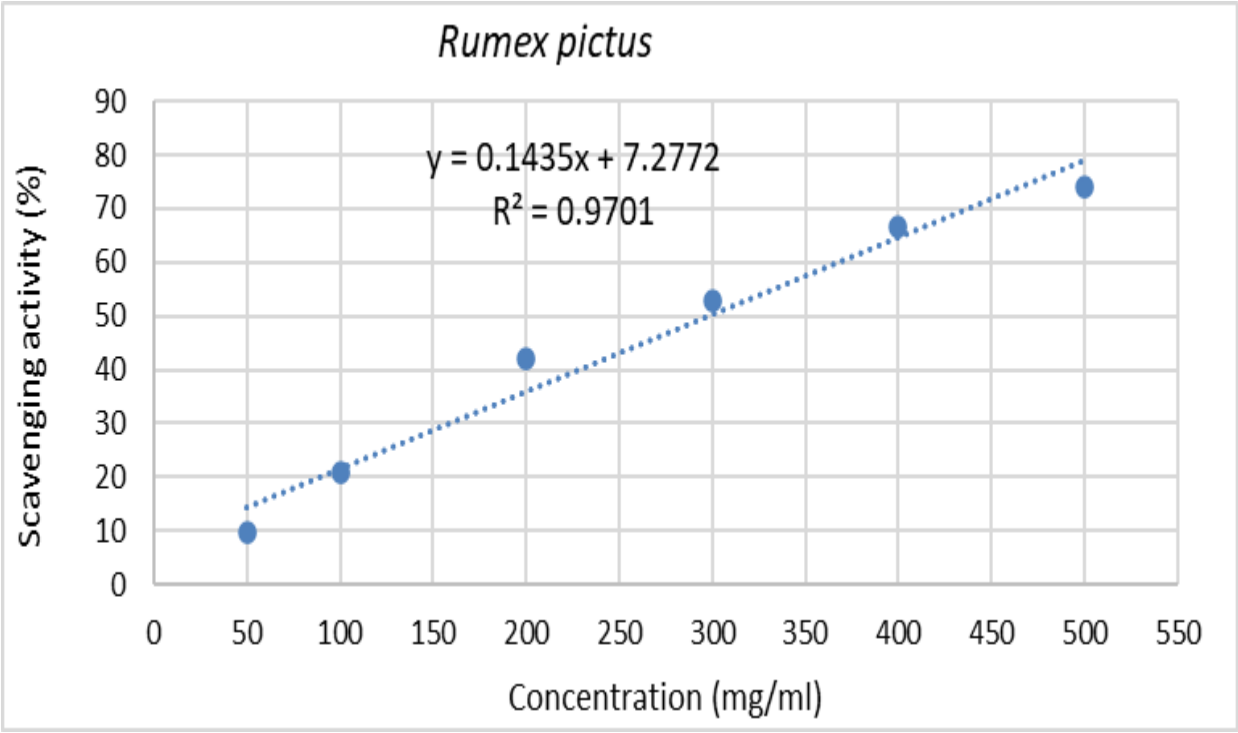

Figure 1. The standard curves of scavenging activities percentages versus the tested sample concentrations.

Table 3. Antibacterial activities represented by the inhibition zone diameter (mm) of the extracted MeOH from *Rumex pictus* and standard antibiotics.

Treatments	Gram-negative bacteria			Gram-positive bacteria			
	Escherichia coli	*Klebsiella pneumonie*	*Salmonella typhi*	*Bacillus cereus*	*Enterococcus faecalis*	*Staphylococcus aureus*	*Staphylococcus haemolytic*
Plant extract (10 mg L^{-1})							
Rumex pictus	14±0.29	11±0.18	15±0.17	18±0.4	13±0.18	17±0.18	12±0.13
Standard antibiotic (10 mg L^{-1})							
Ampicillin	20±0.17	18±0.25	19±0.28	22±0.33	20±0.49	24±0.2	18±0.36
Penicillin	15±0.4	12±0.12	14±0.4	20±0.19	19±0.13	22±0.57	16±0.58
Chloramphenicol	18±0.5	17±0.25	18±0.15	19±0.44	17±0.32	20±0.16	17±0.35
Gentamicin	22±0.12	21±0.55	20±0.23	23±0.43	21±0.26	25±0.36	20±0.37

When compared with standard antibiotics, the plant extract demonstrated weaker antibacterial effects. For instance, gentamicin showed the strongest activity overall, with inhibition zones ranging from 20 to 25 mm, followed by ampicillin (18–24 mm), penicillin (12–22 mm), and chloramphenicol (17–20 mm). Despite being less potent, the extract's activity is notable, particularly against *B. cereus* and *S. aureus*, where it achieved inhibition zones that approach those of chloramphenicol. This suggests that *R. pictus* contains bioactive compounds with significant antibacterial potential, likely related to its high content of flavonoids, phenols, anthraquinones, and glycosides identified in the phytochemical screening. These classes of metabolites are widely reported for their ability to disrupt bacterial cell walls, interfere with nucleic acid synthesis, and inhibit enzyme function [24,22].

The differential susceptibility between Gram-negative and Gram-positive bacteria observed in this study may be explained by differences in cell wall structure. Gram-negative bacteria possess an outer membrane rich in lipopolysaccharides, which often reduces permeability to many plant-derived compounds, thereby lowering sensitivity [30] (Nikaido, 2003). In contrast, Gram-positive bacteria, with their relatively porous peptidoglycan layers, tend to be more susceptible, as reflected by the strong activity against *B. cereus* and *S. aureus*.

Overall, the antibacterial results support the ethnomedicinal use of Rumex species and provide evidence for the therapeutic potential of *R. pictus*. Although less effective than conventional antibiotics, the extract may offer a natural alternative or complementary source of antibacterial agents, particularly in the context of rising antibiotic resistance. Further purification and characterization of individual compounds, especially flavonoid and anthraquinone derivatives, could enhance the observed antibacterial activity and lead to the discovery of novel antimicrobial agents.

4. Conclusion

In conclusion, this study demonstrates that *Rumex pictus* is a rich source of diverse phytochemicals, particularly flavonoids, phenols, and anthraquinones. The methanolic extract exhibited significant, dose-dependent antioxidant activity and broad-spectrum antibacterial effects against both Gram-positive and Gram-negative bacteria. These findings scientifically validate the traditional uses of this plant and position it as a promising natural candidate for combating oxidative stress and microbial infections. Further research to isolate, purify, and identify the specific active compounds is recommended to fully elucidate its therapeutic potential and develop novel pharmacological applications.

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