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QUALITATIVE EVALUATION OF PHYTOCHEMICALS IN TAMARIX APHYLLA: A PRELIMIARY INVESTIGAATION

Original Article

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ABSTRACT

Background: Plants are rich sources of bioactive compounds, contributing significantly to healthcare by offering protection against microbial infections and other non-infectious ailments. Tamarix aphylla, commonly known as Athel tamarisk, is a halophytic plant widely recognized for its ethnopharmacological uses. Its secondary metabolites, including alkaloids, flavonoids, tannins, and saponins, exhibit therapeutic potential. This study aimed to explore the phytochemical composition, antioxidant properties, and chemical constituents of the ethyl acetate extract of Tamarix aphylla.

Objective: To analyze the phytochemical composition, evaluate antioxidant activity, and identify bioactive components in the ethyl acetate extract of Tamarix aphylla leaves.

Methods: The leaves of Tamarix aphylla were collected, air-dried, and powdered. Ethyl acetate was used as the solvent for extraction. Phytochemical screening tests were conducted using standard protocols to detect the presence of alkaloids, flavonoids, tannins, saponins, steroids, and triterpenoids. Antioxidant activity was assessed via the DPPH assay, and the IC50 value was determined. Quantification of total phenolic content was performed using gallic acid equivalents (GAE).

Results: Phytochemical screening confirmed the presence of tannins, flavonoids, saponins, and alkaloids, while steroids and triterpenoids were absent. Total phenolic content was measured at 39.3 mg GAE/g extract. Antioxidant activity showed an inhibition range of 22.1% to 66.3% at concentrations of 1–25 mg/mL, with an IC50 value of 14.0 mg/mL compared to 9.0 mg/mL for vitamin C. Methanol was identified as the most effective solvent for metabolite extraction.

Conclusion: The ethyl acetate extract of Tamarix aphylla demonstrates promising antioxidant activity and contains a variety of bioactive phytochemicals. This highlights its potential for therapeutic applications, warranting further research into its pharmacological properties and mechanisms of action.

Keywords: Alkaloids, Antioxidants, Flavonoids, Phenols, Phytochemistry, Saponins, Tannins

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INTRODUCTION

Plants have long been regarded as a cornerstone of traditional medicine and an invaluable resource for therapeutic and economic purposes. It is estimated that approximately 80% of the global population relies on plant-based traditional remedies for healthcare, particularly in developing countries (Schultes et al., 1994). The World Health Organization (WHO) acknowledges the significance of medicinal plants, with more than 150 species identified for their potent antidiabetic properties. These ancient remedies, derived from flora, have shaped traditional medicine systems and continue to contribute to healthcare practices worldwide. Tamarix aphylla, a member of the Tamaricaceae family, is among the notable medicinal plants whose phytochemical composition and pharmacological potential demand comprehensive exploration. The genus Tamarix, comprising around 60 species, is characterized by small trees and shrubs with distinct morphological features such as scale-like leaves, pinkish or white flowers, and feathery foliage. These plants are well-adapted to saline and arid environments, thriving in regions such as the Middle East, Africa, and South Asia. Tamarix species have been extensively utilized in traditional medicine to treat various ailments, including liver disorders, headaches, and gastrointestinal issues (Kritikar and Basu, 1933). Tamarix aphylla, commonly known as Athel tamarisk, holds a prominent place among these species due to its unique botanical features and ethnobotanical uses (Hebi and Eddouks, 2017).

The phytochemical profile of Tamarix aphylla reveals a wealth of bioactive compounds, including flavonoids, tannins, phenolic acids, steroids, and cardiac glycosides. These secondary metabolites exhibit diverse pharmacological activities such as antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties (Souliman et al., 1991; Ksouri et al., 2009; Meot-Duros et al., 2008). The plant's traditional applications range from wound healing and joint pain relief to the treatment of diabetes and infections (Panhwar and Abro, 2007; Yusufoglu et al., 2015). Modern research has confirmed the plant's efficacy, with studies highlighting its antioxidant potential, antimicrobial activity, and role in alleviating chronic diseases, including cancer (Alshehri et al., 2023; Khan et al., 2023). Tamarix aphylla's ability to tolerate harsh environmental conditions such as salinity, drought, and extreme temperatures makes it an ecologically significant species. Its deep root system and salt-secreting glands enhance its resilience and adaptability, allowing it to stabilize sand dunes, act as a windbreak, and prevent soil erosion in arid landscapes (Griffin et al., 1989; Malik and Sheikh, 1983). Furthermore, the plant exhibits allelopathic effects, releasing allelochemicals that influence the germination and growth of other plant species, which could have potential applications in sustainable weed management (Khalid et al., 2022). The medicinal importance of Tamarix aphylla extends beyond its phytochemical properties. Its leaves, bark, and other parts have been traditionally used to treat a wide range of ailments, including tuberculosis, leprosy, jaundice, and gum infections. Extracts from the plant have demonstrated significant therapeutic effects, such as antioxidant activity and free radical scavenging, which are crucial in managing oxidative stress-related diseases (Othman et al., 2019; Suleiman et al., 2015). Despite these promising findings, the pharmacological potential of Tamarix aphylla remains underexplored, warranting further investigation to isolate and characterize its bioactive constituents. This study aims to bridge the existing knowledge gaps by providing a qualitative evaluation of the phytochemical composition of Tamarix aphylla. The objective is to rationalize its traditional and pharmacological applications through scientific validation, laying the groundwork for future research on its therapeutic potential and sustainable utilization in medicine and agriculture.

METHODS

The research was conducted to evaluate the phytochemicals in Tamarix aphylla through standardized procedures, adhering to precise laboratory protocols. The shoot parts of Tamarix aphylla were collected from the field at Gomal University, Dera Ismail Khan. The collection site was located near the central mosque and the Biological Sciences Department. While gathering the plant material, care was taken to select healthy leaves, ensuring the structural integrity of the plant was not compromised. After collection, the leaves were dried in a controlled environment. Initially, they were kept at room temperature under shaded conditions for three to four days to prevent degradation of phytochemicals due to direct sunlight. Subsequently, the leaves were placed in a laboratory oven at a temperature range of 104–105°C, covered with aluminum foil to minimize contamination. The drying process continued daily until the leaves reached the desired dryness after 2–3 days. Once dried, the leaves were ground into a fine powder using a mortar and pestle to facilitate further extraction processes. The powdered plant material was then weighed accurately using a laboratory balance. The weight machine was standardized to ensure precise measurements by setting the scale to zero before placing the powdered sample on a paper atop the machine. The measured powdered material was transferred into a beaker containing methanol, where it was immersed for extraction. The beaker was sealed with aluminum foil to avoid contamination and minimize evaporation of methanol. The methanol-soaked sample was subjected to sterilization using a laboratory shaker machine, where it was shaken for approximately 30 minutes. This ensured adequate mixing and extraction of phytochemicals into the methanol solution. Following sterilization, the solution underwent filtration to separate the methanol extract from the plant residues. The filtration setup included a funnel mounted on a stand, filter paper, a beaker for collecting the filtrate, and a glass stirrer to facilitate the filtration process. Methanol was used to clean all filtration apparatus prior to use to ensure accuracy and sterility. The plant residue was gently stirred during filtration to ensure complete extraction of the liquid. The filtration process was stopped once the residue was completely dry and free of methanol. The pure filtrate was collected in a beaker and covered with aluminum foil to preserve its integrity for subsequent testing. The filtrate of Tamarix aphylla was subjected to a series of standard phytochemical tests to identify the presence of key bioactive compounds. These tests included assays for alkaloids, saponins,

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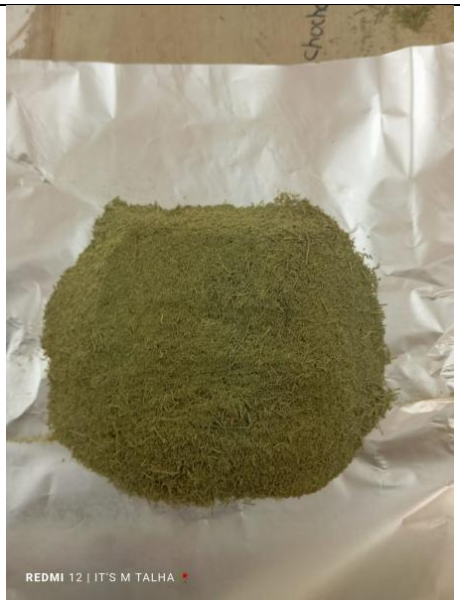
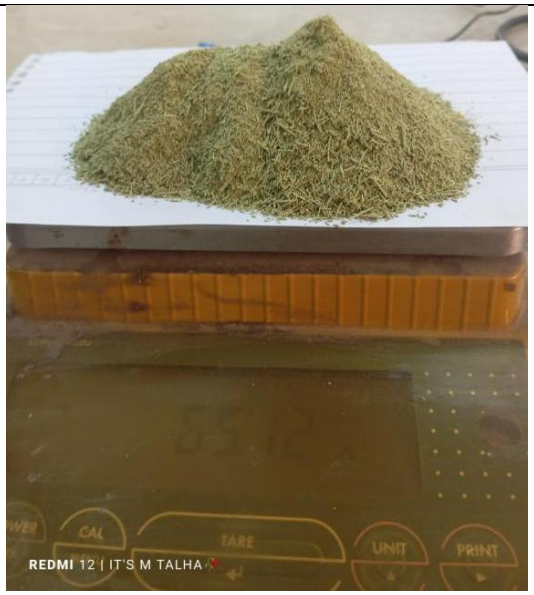
flavonoids, terpenoids, and tannins. All tests were performed using appropriate laboratory equipment, including test tubes, reagents, and other required chemicals, to ensure the accuracy of results.





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RESULTS

The phytochemical analysis of Tamarix aphylla revealed the presence of several secondary metabolites in the ethyl acetate and aqueous extracts. In the ethyl acetate extract, tannins, flavonoids, saponins, and terpenoids were identified as present, while alkaloids and steroids were absent. Tannins gave a positive result using Braymer's test, while flavonoids were detected using lead acetate. The foam test confirmed the presence of saponins, and terpenoids were identified using Salkowski's test. In contrast, picric acid and Liebermann-Burchard tests confirmed the absence of alkaloids and steroids, respectively.

Group Presence		
Tannins +.	(Braymer's test).	Possitive
Alkaloids -	(picric acid test).	Negative
Flavonoids +.	(Leae Acetate).	Possitive
Saponins +.	(Foam test).	Possitive
Terpenoids +.	(Salkowskis test).	Possitive
Steroids -		Negative

TEST	REAGENT	OBSERVATION
Alkaloids	Dragondroff,wagner,mayer	+
Tanins	1% feCl3	+
Flavonoids	Magnesium turning	+
Cardiac glycosides	Keller mililani test	_
Saponins	shaking	+
phenols	1%feCl3	+
Steroids	Liebermann burchard	_
Glycosides	benedict	+
Terpenoids	Salkowski	_

The aqueous extract further validated the presence of additional bioactive compounds. The Dragendorff, Wagner, and Mayer reagents confirmed alkaloids, while 1% ferric chloride was used to detect tannins and phenols. Flavonoids were identified with the magnesium-turning method, and glycosides tested positive using Benedict's test. However, terpenoids and steroids were absent in this extract, as indicated by Salkowski and Liebermann-Burchard tests. Total phenolic content was quantified at 39.3 mg gallic acid per gram of extract, confirming a high level of phenolic compounds. The antioxidant activity of the ethyl acetate extract was evaluated through the DPPH assay, with inhibition percentages ranging from 22.1% at a concentration of 1 mg/mL to 66.3% at 25 mg/mL. The IC50 value for Tamarix aphylla was recorded at 14.0 mg/mL, compared to the IC50 of 9.0 mg/mL for vitamin C. This indicates a moderate but significant antioxidant potential of the extract. Preliminary screening also suggested positive results for flavonoids, tannins, and phenols, which are known to contribute to antioxidant and antimicrobial properties. The study further observed that the presence of tannins and glycosides in the plant extracts was confirmed by tests using ferric chloride, Tollen's reagent, and p-anisaldehyde. These findings align with the secondary metabolites typically associated with antimicrobial, antioxidant, and anticancer properties (Anyasor et al., 2010). Despite the absence of steroids and terpenoids in the aqueous extract, the results indicate a substantial pharmacological potential due to the presence of other critical secondary metabolites.

DISCUSSION

The phytochemical analysis of Tamarix aphylla highlights its potential as a source of bioactive compounds with significant medicinal value. The presence of tannins, flavonoids, saponins, alkaloids, and phenols in the extracts suggests a broad spectrum of pharmacological applications. Tannins, phenols, and flavonoids, in particular, are well-documented for their antioxidant and antimicrobial activities,

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which contribute to the plant's therapeutic potential. The quantified total phenolic content further underscores the plant's capacity to act as a free radical scavenger, supporting its potential use in managing oxidative stress-related disorders. The antioxidant activity demonstrated in this study aligns with existing literature that attributes biological effects, such as anti-inflammatory, antimicrobial, and anti-cancer properties, to phenolic compounds and flavonoids. The IC50 value of the ethyl acetate extract indicates moderate antioxidant efficacy, which, while lower than that of vitamin C, is still noteworthy given the plant's natural origin and potential therapeutic applications. However, the absence of steroids and terpenoids in the aqueous extract could be considered a limitation in terms of the diversity of bioactive compounds. The absence of cytotoxic effects at low and moderate concentrations further enhances the safety profile of Tamarix aphylla, making it a viable candidate for therapeutic applications. While the study establishes the plant's phytochemical richness, the variability in the presence of alkaloids across different tests and extraction methods suggests the need for further investigation using advanced analytical techniques. Such discrepancies could be attributed to environmental factors, extraction protocols, or seasonal variations.

One of the strengths of the study is its comprehensive approach to phytochemical screening, employing both qualitative and quantitative methods to validate the presence of bioactive compounds. However, a limitation lies in the lack of molecular-level validation of the mechanisms by which these compounds exert their pharmacological effects. The study also does not explore the synergistic effects of these metabolites, which could further enhance their therapeutic efficacy. The results support the traditional use of Tamarix aphylla in treating ailments such as inflammation, microbial infections, and oxidative stress-related conditions. However, the absence of detailed molecular studies and clinical validations represents a significant gap that needs to be addressed. Future research should focus on isolating and characterizing the specific bioactive compounds and validating their mechanisms of action at the molecular level. This could pave the way for the development of novel therapeutic agents derived from Tamarix aphylla, enhancing its applicability in modern medicine.

CONCLUSION

The findings of this study highlight the significant inhibitory and toxic effects of Tamarix aphylla leaf extracts on various biological systems, with wheat seeds exhibiting greater sensitivity to the extracts. This suggests the presence of bioactive compounds that may hold potential for agricultural and environmental applications. While these results point to the extract's growth-regulating and potentially beneficial properties, further exploration is essential to understand its positive uses fully. Investigations into the plant's fiber viability have also revealed insights into its structural stability, emphasizing its longevity and resilience. These observations underscore the importance of continued research to harness the plant's potential for sustainable agricultural practices, environmental safety, and innovative applications in various fields, ensuring that its bioactive compounds are used effectively and responsibly.

AUTHOR CONTRIBUTIONS

Author	Contribution
Saif U Din	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Zahidullah Khan	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Ejaz Hussain	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Waqas	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Talha	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sundus Fayaz	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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