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Phytochemical Analysis of Libyan Urginea Maritima and Its Potential Antibacterial Activity

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التحليل الكيميائي النباتي لنبات "الأرجينيا البحرية" الليبي ونشاطه المحتمل المضاد للبكتيريا

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Abstract:
This study investigates the phytochemical composition and antibacterial properties of Libyan Urginea maritima powder extracts. Phytochemical analysis identified the presence of secondary metabolites, including flavonoids, glycosides, tannins, and terpenes, while alkaloids and saponins were not detected. The total phenolic content (TPC) of the extracts was quantified in gallic acid equivalents (mg GAE/g), with the methanol extract exhibiting the highest TPC (36.56 mg GAE/g), followed by the chloroform extract (18.36 mg GAE/g) and n-hexane extract (7.17 mg GAE/g). Similarly, the total flavonoid content (TFC) was highest in the methanol extract (13.63 mg QE/g), with the chloroform extract (6.41 mg QE/g) and n-hexane extract (4.80 mg QE/g) showing lower values. The methanol extract demonstrated notable antibacterial activity, producing inhibition zones of 12 mm against Staphylococcus epidermidis and 10 mm against Staphylococcus aureus. These results highlight the potential of L.U. maritima as a natural source of bioactive compounds with applications in managing oxidative stress and microbial infections. Further studies are warranted to isolate and characterize the active constituents, which may lead to the development of novel therapeutic agents.

Keywords: Phytochemical, Urginea Maritima, Extract, Bioactive and Antibacterial Properties.

الملخص

تتناول هذه الدراسة التركيب الكيميائي النباتي والخصائص المضادة للبكتيريا لمساحيق مستخلصات نبات "الأرجينيا البحرية" الليبي. كشف التحليل الكيميائي النباتي عن وجود المستقلبات الثانوية مثل الفلافونويدات، والجليكوزيدات، والعفص، والتربينات، في حين لم يتم الكشف عن القلويدات والصابونين. تم قياس إجمالي محتوى الفينولات (*TPC*) في المستخلصات باستخدام مكافئات حمض الجاليك (ملغم *GAE*/غرام)، حيث سجل مستخلص الميثانول أعلى قيمة (36.56 ملغم *GAE*/غرام)، يليه مستخلص الكلوروفورم (18.36 ملغم *GAE*/غرام) ومستخلص الهكسان (7.17 ملغم *GAE*/غرام). وبالمثل، كان إجمالي محتوى الفلافونويد (*TFC*) الأعلى في مستخلص الميثانول (13.63 ملغم *QE*/غرام)، بينما أظهر مستخلص الكلوروفورم (6.41 ملغم *QE*/غرام) ومستخلص الهكسان (4.80 ملغم *QE*/غرام) قيمًا أقل. أظهر مستخلص الميثانول نشاطًا ملحوظًا مضادًا للبكتيريا، حيث بلغت مناطق التثبيط 12 ملم ضد بكتيريا *Staphylococcus epidermidis* و10 ملم ضد *Staphylococcus aureus*. تسلط هذه النتائج الضوء على إمكانيات نبات "الأرجينيا البحرية" كمصدر طبيعي للمركبات الفعالة حيويًا التي يمكن أن تُستخدم في معالجة الإجهاد التأكسدي والعدوى الميكروبية. ويوصى بإجراء دراسات إضافية لعزل المكونات النشطة وتوصيفها، مما قد يؤدي إلى تطوير عوامل علاجية جديدة.

الكلمات المفتاحية: التحليل الكيميائي النباتي، الأرجينيا البحرية، المستخلص، الخصائص الحيوية والمضادة للبكتيريا

Introduction

Libya, located in North Africa, is characterized by a diverse range of ecosystems, from arid deserts to Mediterranean coastal plains [1]. This variation in climate and geography contributes to the country's rich and unique flora [2]. Libyan vegetation includes a mix of desert-adapted plants, such as acacias [3], tamarisks, and succulents, as well as Mediterranean species like olive trees, junipers, and aromatic herbs [4,5]. Endemic plants, particularly those found in the mountainous regions of Jabal Nafusa and the Green Mountain (Jabal Akhdar), add to its botanical significance [6,7]. These native plants not only play a crucial role in the ecological balance but also hold cultural and medicinal value, having been used traditionally for food, medicine, and crafts [8]. Libyan Urginea maritima L. Baker, a perennial bulbous plant belonging to the Liliaceae family, is a geophyte well-adapted to the Mediterranean climate [9]. It is primarily distributed across hillsides, sandy coastal areas, and various regions within North Africa, the Middle East, and Europe [10]. The plant is classified into two varieties: red and white [11]. In Libya and other parts of North Africa, the red variety (red squill) is more prevalent [12], while the white variety is common in regions like Morocco [13]. Phytochemical analyses of Urginea maritima bulbs have revealed the presence of compounds such as glycosides, flavonoids, anthocyanins, fatty acids, and polysaccharides [14-16]. Furthermore, bulb extracts have demonstrated insecticidal properties, leading to interest in their potential application against various pests [17,18]. This study focuses on evaluating the phytochemical profile of the three extracts of Libyan Urginea maritima, and assessing its antibacterial activities.

Material and Methods

Plant Material

Bulbs of Urginea maritime were harvested from the green mountain region, Libya, during December 2023. The bulbs were air-dried for several days, ground into coarse powder using a dry mill, and extracted by soaking 100 g of the powdered material in three different solvents (n-hexane, chloroform and methanol) for two days at room temperature, with solvent renewal. The resulting extracts were dried using rotary evaporation and stored for further work.

Phytochemical Screening

Phytochemical tests were performed to identify various biochemical components, such as alkaloids, terpenes, flavonoids, saponins, glycosides, and tannins. The detection was based on visual color changes or precipitate formation when specific reagents were added to plant extracts prepared in solvents of increasing polarity [19].

Quantification of total flavonoids and polyphenols

The Folin-Ciocalteu method was used to determine polyphenol content, which was represented in milligrams of gallic acid equivalents per gram. Flavonoids were measured using aluminum chloride reagent and represented as quercetin and rutin equivalents (mg QEq and R Eq/g) [20].

Antibacterial Activity

The antibacterial potential of the three extracts were tested against Staphylococcus epidermidis (S. epidermidis) and Staphylococcus aureus (S. aureus) using the disc diffusion method. Plant extracts dissolved in DMSO at various concentrations were applied to discs placed on agar inoculated with bacterial suspensions. Zones of inhibition were measured after 48 hours of incubation at 37°C [21].

Results and Discussion

The results and discussion section provides an analysis of the following aspects: Phytochemical Screening, Quantification of Total Polyphenols and Flavonoids, and the evaluation of Antimicrobial Activity.

Phytochemical Screening

Table 1 illustrates summary of phytochemical constituents of Urginea maritime extracts.

Table 1: Summary of phytochemical constituents of Urginea maritime extracts.

Extracts	Alkaloids	Glycosides	Flavonoids	Saponins	Tannins	Terpenoids	TPC (mg GAE/g)	TFC (mg QE/g)
n-Hexane	-	-	-	-	-	+	7.17	4.80
Methanol	-	+	+	-	+	+	36.56	13.63
Chloroform	-	-	+	-	+	-	18.63	6.41

(+): existence; (−): nonexistence.

Analysis of Urginea maritima powder identified various secondary metabolites, including flavonoids, glycosides, tannins, and terpenes. However, alkaloids and saponins were not detected.

Total Polyphenols and Flavonoids

The total amount of phenolic compounds of the three extracts were quantified in gallic acid equivalents (mg GAEq/g), while flavonoids were quantified in quercetin and rutin equivalents. The methanol extract displayed a high phenolic content (36.56 mg GA Eq/g and n-hexane extract showed the lowest value of TPC 7.17 mg GAE/g while the Chloroform extract contained 18.36 GAE/g. Nevertheless, the total flavonoid content of the extracts were similar to the latter with the highest value in methanol extract (13.63 mg QE/g) followed by the chloroform extract (6.41 mg QE/g) while n-hexane extract contain the lowest TFC with 4.80 mg QE/g.

The findings highlight that Urginea maritima contains a diverse range of secondary metabolites, such as polyphenols, flavonoids, tannins, and glycosides, which are known for their pharmacological significance. Polyphenols, in particular, are recognized for their antioxidant properties, effectively scavenging free radicals and reducing oxidative stress. The presence of flavonoids enhances these effects, as they are capable of neutralizing hydroxyl radicals and lipid peroxides.

Antimicrobial Activity

Table 2 presents inhibition zones in mm for Urginea maritima extracts.

Table 2: Inhibition zones in mm for Urginea maritima extracts.

Bacterial types	Extracts inhibitory zones (mm)		
	n-hexane	Methanol	Chloroform
S. aureus	-	10	2
S. epidermidis	-	12	4

The Methanol extract exhibited antibacterial activity against both bacterial strains. The highest inhibition zone was observed against S. epidermidis (12 mm), and S. aureus (10 mm). The antibacterial activity of the extracts against bacterial strains, can be attributed to its bioactive constituents, such as flavonoids and glycosides, which are known for their antimicrobial properties. These findings align with previous studies demonstrating the efficacy of plant-based extracts against pathogens. The results demonstrated that the plant extract possesses antibacterial activity against two specific bacterial strains, indicating the presence of biologically active compounds with antimicrobial properties.

An analysis of the effects of different concentrations revealed that the antibacterial activity increased with higher extract concentrations, confirming a dose-response relationship. This suggests that the efficacy of the extract is significantly influenced by the concentration of active compounds, such as phenolic compounds, which exhibit high inhibitory activity at elevated concentrations. The inhibition zones observed on the agar plates varied in size depending on the type of bacteria targeted. This variation can be explained by differences in the structure of the bacterial cell wall.

Overall, the results confirm that Urginea maritima methanolic extract is a rich source of bioactive compounds with significant antioxidant and antibacterial activities. These properties support its

traditional use in managing infections and oxidative stress-related disorders, and further isolation of active constituents could lead to the development of new therapeutic agents.

Conclusion

This study revealed that Urginea maritime contains a variety of secondary metabolites, including flavonoids, tannins, glycosides, and terpenoids. The Methanol extract demonstrated good antibacterial activities, which can be attributed to their rich polyphenol and flavonoid content. Suggesting that Urginea maritima has the potential to serve as a natural source of bioactive compounds for managing oxidative stress and microbial infections. Further research focusing on the isolation and characterization of its active constituents could pave the way for the development of novel therapeutic agents.

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