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TOPIC

Phytochemical Profile, Antioxidant and Anti-inflammatory Activities of *Anagallis arvensis* L

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ملخص

ينتمي نبات عين الجمل *Anagallis arvensis* L إلى فصيلة الربيعيات(Primulaceae) ، وهم من الأنواع النباتية ذات الأهمية في الدراسات الكيميائية النباتية. تهدف هذه الدراسة إلى التحديد الكيميائي النوعي والكمي للمركبات الأيضية الثانوية، بالإضافة إلى تقييم الفعالية المضادة للأكسدة وللالتهاب للمستخلص المائي للجزء الهوائي للنبات، والذي تم تحضيره عن طريق الغلي(Decoction) . قدر مردود الاستخلاص ب 17.76%. كشف التحليل الكيميائي الأولي (Phytochemical Screening)عن وجود مجموعة متنوعة من المركبات النشطة بيولوجياً، شملت السابونين،التربينويدات، مع تسجيل وجود عديدات الفينول و الدباغ بنسب ضئيلة. وفيما يخص التقدير الكمي للمركبات الفينولية، أظهرت النتائج أن المحتوى الكلي لعديدات الفينول المقاس بطريقة Folin-Ciocalteu، بلغ 66.25 mg GAE/g من المستخلص. كما سجل محتوى الفلافونيدات نسبة قدرها 17.39±0.67 mg QE/gمن المستخلص، بينما بلغت تراكيز الفلافونولات والدباغ ب 8.86±2.32 µgQE/mg من المستخلص و110±10.29 µgCE/mg من المستخلص على التوالي. تم تقييم القدرة المضادة للأكسدة للمستخلص المائي باستخدام ثلاثة اختبارات مخبرية متكاملة. في اختبار تثبيط الجذور الحرةDPPH ، أظهر المستخلص فعالية ملحوظة بقيمةIC_{50} بلغت15.63±46.40 µg/mL ، مقارنة بمركب BHA المرجعي 2.60±2.76 µg/mL . أما في اختبار القدرة الإرجاعية للحديد(FRAP) ، فقد سجل المستخلص قيمةEC_{50} قدرها 89.63±936.36 µg/mL مقابل 6.71±56.37 µg/mL للمركب المرجعي BHA. ومن جهة أخرى، كشف اختبار السعة الكلية المضادة للأكسدة (TAC) عن نتائج متميزة، حيث بلغت قدرة المستخلص 0.8±178% مقارنة بحمض الأسكوربيك، ووصلت إلى 0.98±218.1% مقارنة بمركب الكيرسيتين.وفيما يخص الفعالية المضادة للالتهاب، أظهر المستخلص قدرة ممتازة على تثبيط تمسخ البروتين (BSA) بقيمةIC_{50} بلغت 207.69 µg/mL ، متفوقاً بشكل ملحوظ على الدواء المرجعي الأسبرين الذي سجل 389.81µg/mL . تبرز هذه النتائج الإمكانيات الواعدة لنبات *Anagallis arvensis*كمصدر طبيعي غني بمضادات الأكسدة ومضادات الالتهاب، مما يفتح آفاقاً لمزيد من البحوث المعمقة حول تطبيقاته البيولوجية والصيدلانية.

الكلمات المفتاحية: اختبارFRAP ، اختبارDPPH ، *Anagallis arvensis* L ،عديدات الفينول ، الفلافونيدات، الفعالية المضادة للأكسدة، الفعالية المضادة للالتهاب.

Abstract

The plant *Anagallis arvensis* L. belonging to the Primulaceae family, is considered as a biologically significant species in phytochemical studies. This study aims to conduct a qualitative and quantitative chemical characterization of secondary metabolites, in addition to evaluating the antioxidant and anti-inflammatory activities of the aqueous extract of the plant aerial parts, prepared via the decoction method. The extraction process yielded a recovery rate of 17.76%.Preliminary phytochemical screening revealed a diverse range of bioactive compounds, including saponins, terpenoids, while polyphenols and tannins were recorded in trace amounts. Regarding the quantitative estimation of phenolic compound, results showed that the total polyphenol content, measured by the Folin-Ciocalteu method, reached 66.25 mg GAE/g of extract. Flavonoid content was recorded at 17.39±0.67 mg QE/gof extract, while flavonol and tannin concentrations were 8.86±2.32 (µgQE/mg of extract) and 110±10.29 (µgCE/mg of extract) respectively.The antioxidant capacity of the aqueous extract was evaluated using three integrated *in vitro* assays. The DPPH radical scavenging assay: The extract demonstrated notable activity with an IC_{50} value of 46.40±15.63 µg/mL, compared to the BHA reference (2.60±2.76 µg/mL).In Ferric Reducing Antioxidant Power (FRAP) test, the extract recorded an EC_{50} value of 936.36±89.63 µg/mL, versus 56.37±6.71 µg/mL for the BHA reference. For the Total Antioxidant Capacity (TAC): results revealed superior performance, with the extract reaching 178±0.8% relative to ascorbic acid and 218.1±0.98% relative to quercetin.Regarding the anti-inflammatory activity, the extract demonstrated a potent capacity to inhibit protein (BSA) denaturation, recording an IC_{50} value of 207.69 µg/mL, which significantly outperformed the reference drug, Aspirin, which recorded 389.81µg/mL.These findings highlight the promising potential of *Anagallis arvensis* L. as a rich natural source of antioxidants, opening horizons for further in-depth research regarding its biological and pharmaceutical applications.

Keywords: *Anagallis arvensis* L., Antioxidant activity, Anti-inflammatory, Aqueous extract, Decoction, DPPH, FRAP, Phytochemical screening, Total polyphenols.

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I. INTRODUCTION

From ancient times, plants have played a vital role in curing and preventing different diseases. Treatments were not only limited to humans but also to animals (Baradaran et al., 2015). One of these plants is *Anagallis arvensis* L (*A. arvensis*) from the family of Primulaceae, popularly known as scarlet pimpernel (Al-Snafi, 2015). It is a summer annual herb which blossoms at the end of spring (Osbornova-Kosinova, 1984).Morphologically, it is characterized by creeping to weakly erect, glabrous, and 4-angular stems (5–30 cm long). Its leaves are opposite, sessile, and ovate to oblong (5–25 mm long). The flowers feature a 5-lobed corolla varying in color from red, pink, and orange to blue, with villous filaments and no staminodes (figure 1). It was widely distributed throughout the world, being found in all temperate regions in both hemispheres, including Africa, Europe, Asia, the United states and non-tropical South America (Salam et al., 2011).

A. arvensis is a plant rich in primary metabolites which contains proteins, fibre, lipids, carbohydrates, minerals, and water-soluble vitamins. It is used in traditional medicine for treatment of gout, rheumatism, diuretic, antifungal diaphoretic, expectorant, hepatic and renal complaints and epileptic attacks (Sundaram et al., 2010; Gulshan et al., 2012).Furthermore, the plant is characterized by the presence of secondary metabolites, such as:flavonoids, saponins, tannins, steroids, glycosides, alkaloids and anthraquinones (Yamada et al., 1978 ;Shoji et al., 1994). Several studies have shown that the main phytochemical components of *A. arvensis* are triterpenoid saponins derived from triterpenes, which are compounds containing 30 carbon atoms arranged in four or five rings (Mahato et al., 1991; De Napoli et al., 1992). They are naturally occurring sugar conjugates of triterpenes possessing various biological activities (Waller and Yahasaki, 1996).However, little is known about their antiviral activities (Konoshima et al., 1995 ; Hayashi et al., 1997)

The plant does not only contain triterpenoid saponins, but it also includes other compounds such as polyphenols like catechin, gallic acid, chlorogenic acid, and ferulic acid(Saleem et al., 2022). It has also been reported to contain different flavonoids, including kaempferol, quercetin, and isorhamnetin, in addition to anthocyanins (Kawashty et al., 1998).Polyphenols are natural compounds synthesized exclusively by plants and eliciting strong antioxidant properties(Singla et al., 2019). Therefore, They were categorized under phenolic acids, flavonoids, stilbenes, lignans and other polyphenols together with xanthones, tannins and anthraquinones (Prabhu et al., 2021). Flavonoids are a subclass of polyphenols.

They generally consist of two aromatic rings, each containing at least one hydroxyl, which are connected through a three-carbon bridge and become part of a six-membered heterocyclic ring (Beecher, 2003). They are classified into different classes: Flavanols, anthocyanidins, isoflavones, flavones, flavonols, flavanones, and flavanonols wich play important roles in plant physiology (Singla et al., 2019). Tannins are a group of polyphenolic compounds that are widely present in different parts of plants, such as roots, bark, leaves, and fruits. They are generally soluble in polar solution and are distinguished by their phenolic nature. Chemically, tannins are commonly classified into two main types: hydrolyzable tannins and condensed tannins (Silanikove et al., 2001). Tannins can help protect the body because they act as antioxidants. They neutralize free radicals, bind metals, and support the body's natural defenses. This helps explain their anti-inflammatory, antimicrobial, and protective effects (Camarda et al., 2026).

The secondary metabolites are directly responsible for the diverse pharmacological activities exhibited by *A.arvensis* including a significant antioxidant activity characterized by a high free radical scavenging capacity and low IC_{50} values. Regarding its anti-inflammatory potential, the plant has shown a remarkable ability to inhibit cyclooxygenase (COX) enzymes and reduce prostaglandin synthesis, with saponins and flavonoids identified as the primary active constituents (Lopez et al., 2011). Furthermore, it demonstrates cytotoxic activity, showing a dose-dependent effect in decreasing cell survival across specific cell lines such as PC12 (Lopez & Cavero, 2013). Additionally, *A. arvensis* possesses notable antimicrobial properties; it has been found to inhibit the growth of various bacterial strains and fungi, a characteristic largely attributed to the presence of saponins which can cause direct damage to microbial cells(Ali-Shtayeh et al., 1998). Finally, the plant exhibits potent antiviral properties against viruses such as HSV-1 and poliovirus, where its triterpenoid saponins effectively inhibit viral cytopathogenesis and replication(Amoros & Girre, 1987).

Reactive Oxygen Species (ROS) are chemically active molecules derived from oxygen, encompassing both free radicals such as the superoxide anion ($O_2^{\bullet -}$) and hydroxyl radical ($OH^{\bullet}$) and non-radical oxidizing agents like hydrogen peroxide (H_2O_2) (Halliwell & Gutteridge, 1989). Although ROS are naturally produced during normal cellular metabolism and play vital roles in signal transduction, their excessive accumulation leads to oxidative stress, which is defined as an imbalance caused by an increase in the production of ROS and other oxidants that exceeds the antioxidant capacity of the living body (Nakai & Tsuruta,

2021), causing significant damage to proteins, lipids, and DNA(Salvemini & Cuzzocrea, 2002).To counteract these harmful effects, the biological system relies on Antioxidants. According to Halliwell and Gutteridge (1995), an antioxidant is defined as any substance that, when present at low concentrations compared with that of an oxidizable substrate, significantly delays or inhibits oxidation of that substrate.These antioxidants can be classified into three main types: enzymatic antioxidants, including Superoxide dismutase, Catalase, and Glutathione peroxidase, natural antioxidants, which encompass Vitamin E, Vitamin C, carotenoids, flavonoids, phenolic acids, and minerals like selenium and zinc; and synthetic antioxidants, such as BHA, BHT, Propyl Gallate, and TBHQ (Shebis et al., 2013).As previously mentioned, polyphenols and flavonoids are considered potent natural antioxidants; given that *Anagallis arvensis* L. is rich in these bioactive compounds, it is considered a significant plant with potential antioxidant activity.

Based on these insights, this study aims to provide a comprehensive analysis of *Anagallis arvensis* focusing on the aqueous extraction and quantification of its major bioactive constituents, particularly polyphenols, flavonoids, tannins, and flavonols, while evaluating its antioxidant and anti-inflammatory activities. These activities will be assessed using *in vitro* assays, including DPPH, FRAP, TACand BSA tests.



Figure 1 : Photo of *Anagallis arvensis* taken at the Ferhat Abbas University campus.