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Phytochemical Screening and Antioxidant Activities of the Aerial Parts of *Fagonia arabica (Zygophyllaceae)*

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Abstract: Various phytochemicals and bioactive compounds are sourced from medicinal plants. This study focused on finding the most potent *Fagonia arabica* extract whose combination could exhibit better antioxidant activity compared to the efficacy of the individual extracts. The plant material was treated to extraction using methanol as the solvent, and subsequently, the resulting extract was analyzed.. The research employed quantitative methodologies to evaluate the concentrations of alkaloids, tannins, saponins, flavonoids, and phenols. Furthermore, qualitative phytochemical assays were employed to determine the existence of bioactive substances. The assessment of the extract's antioxidant ability was carried out using DPPH (2,2-Diphenyl-1-picrylhydrazyl). The study's findings indicate that the extract derived from the aerial parts had the highest level of antioxidant scavenging activity, as proven by an IC_{50} value of 58.62 mg/L. It is crucial to recognize, however, that this specific undertaking surpasses the activity of catechol when concentrations beyond an IC_{50} value of 19.07 mg/ml. The historical application of these plants in traditional medicine may be strongly justified by the presence of phytochemicals with antioxidant action.

keywords: Fagonia arabica; Inland Desert; Antioxidant; DPPH, Phytochemical.

1. Introduction

Herbal therapy is recognized as one of the earliest types of healing in human history. The use of natural sources accounts for about 50% of the contemporary pharmaceuticals employed in healthcare, underscoring the significant contribution of natural goods to the advancement of the pharmaceutical industry. Phytochemicals are bioactive compounds produced by plants as a reaction to environmental stressors or pathogenic threats. Although not essential for plant metabolism, they may be advantageous to humans in the management of many ailments. To promote the use of plant materials as potential reservoirs of antimicrobial agents, it is essential to conduct a meticulous assessment of their composition and biological activity prior to their application [1,2]. The creation of new antibacterial medications has been driven by the growth of microbes that are resistant to antibiotics. The escalation in the prevalence of numerous drug-resistant germs may be attributed to the imprudent use or inadequate management of antibiotics, leading to a diminished efficacy of some antibiotics against specific microorganisms [3,4].

Oxidative damage to cells via the breakdown of lipid, protein, and nucleic acid macromolecules is caused when free radicals are formed in an unbalanced manner, leading to abnormal physiological conditions [5]. The repair of oxidative damage resulting from the presence of reactive oxygen species is facilitated by the protective mechanism of antioxidants. These antioxidants play a crucial role in converting the free radicals produced during oxidative stress into less damaging molecules by the interception of radical chain reactions [6]. Bioactive chemicals originating from plants have a crucial function in mitigating oxidative stress by providing protective effects. Several unrefined botanical extracts have significant oxidative potential and

a notable abundance of phenolic components [7].

Genus *Fagonia* is represented in Egypt by 18 species [8], but it was represented by 15 species in Boulos (2000), *Fagonia* species were extensively studied by many researchers regarding their medicinal uses. According to Boulos [9], the genus *Fagonia* is low shrubs or perennial herbs, rarely annuals. *Fagonia arabica* L. (Syns. *Fagonia tilhoana* Maire) is an ethno-pharmacologically important ayurvedic herb known to have many medical properties like anti-inflammatory, analgesic, and antipyretic effects. *Fagonia arabica* by virtue of it is antioxidant potential reduces oxidative stress generated due to ischemia-reperfusion and helps the cells to maintain the cellular ATP and lactic acid levels, thus ultimately prevents cell death due to ischemia / reperfusion [10]. The plant is distributed in sandy plains and desert wadis, in Egypt it occurs in the Mediterranean coastal strip, the oases of the western desert, all the deserts of Egypt and the entire Sinai Peninsula [9].

The objective of this study was to examine the botanical specimen *Fagonia arabica*, sourced from the Northern Eastern Desert, to ascertain its chemical composition and evaluate its antibacterial and antioxidant properties.

2. Materials and Methods

2.1. Plant material

In April 2023, a collection of viable specimens of *Fagonia arabica* was obtained from indigenous xerophytes located in the northern part of the Eastern Desert, specifically in Wadi Araba, Egypt (29°7'21.73"N, 32°21'44.68"E). The process of plant identification was carried out with the aid of Tackholm [11] and Boulos [9] as primary sources of reference. The specimen underwent a process of manual cleansing, after which it underwent three rinses with distilled water to remove any particulate matter and residual contaminants. Following this, the sample was subjected to air-drying under ambient conditions at a temperature of 25 ± 3 ℃ in a shady location for a duration of several days until complete desiccation was attained. Subsequently, the desiccated specimen underwent pulverization to achieve a finely powdered form. Following that, the specimens were meticulously put into paper bags and kept at room temperature, protected from direct light, till further analysis was carried out.

2.2. Extraction

The medicinal components of plants are extracted by conventional solvent extraction [12]. Extraction is the process of removing water-soluble plant components from plants while leaving behind the insoluble cellular remnants. Each dried plant part, totaling 200 grams, was soaked in an 85% methanol solution at room temperature for three days [12]. Cell walls are gently broken down and fragmented to liberate water-soluble phytochemicals. After three days, the filtered solution is ready for use. Conventional methods rely on convection and conduction for heat transmission, and the choice of solvents for sample retrieval [13]. After the extracts were filtered, evaporated, and dissolved in DMSO, they were ready for use.

2.3. Phytochemical constituents

2.3.1. Qualitative phytochemical screening

The process of identifying phytochemical components followed recognized techniques as outlined by Farnsworth [14], Harborne [15], Sofowora [16], and Evains [17].

2.3.2. Quantitative determination of phytochemicals

The procedures utilized in this study for the assessment of tannin, saponin, flavonoid, alkaloid, and total phenol concentrations were those described by Sadasiveam and Manieckam [18], Harborne [15], Bohim and Kocipai-Abyazian [19], and Obadonei and Ochuiko [20].

2.4. Antioxidant activities

The assessment of free radical scavenging activities was performed using an approach that closely resembled the one outlined by Bibi *et al.* [21]. Following the introduction of 180 µl of DPPH solution dissolved in methanol, the sample solution in DMSO achieved a concluding concentration of 100 g/mL. After a 15-minute period of incubation at a temperature of 37 ℃ in the absence of light, the absorbance of the samples was measured at a wavelength of 517 nanometers using a microplate reader.

$$\text{Scavenging activity } (\%) = 100 \times [1 - (\text{Absorbance}_{sample} / \text{Absorbance}_{blank})]$$

3. Results and Discussion

3.1. 3.1. Qualitative phytochemical screening

The species used for the research were selected based on the incorporation of indigenous knowledge and the review of relevant literature pertaining to medicinal plants. Based on the data shown in Table 1, it is apparent that numerous extracts include substantial quantities of alkaloids, tannins, and terpenoids, which are recognized as significant secondary metabolites. The investigation conducted by experts [22] has revealed that triterpenoids exhibit analgesic and anticancer effects. Based on the findings from the cited source [22], it has been shown that saponins demonstrate hypocholesterolemic and antidiabetic qualities, whereas triterpenoids have been found to possess analgesic and anticancer effects. Secondary metabolites have a pivotal function in augmenting the therapeutic capacity of plants. The findings of the qualitative phytochemical screening performed on the powder and crude extract of *F. arabica* are presented in Table 1. The qualitative screening involves well-established techniques that determine the presence or absence of phytochemicals in aqueous extracts.

In this study, the assessment of phytoconstituents was quantified using a numerical scale ranging from -1 to +4. This scale was determined based on the degree of color change seen or the amount of precipitate formed. Therefore, it was possible to assess the bioactive chemicals found in the native plant by a qualitative study. The samples displayed varying levels of alkaloids, flavonoids, phenols, saponins, and tannins, as documented in Table 1. However, several samples have exhibited the presence or absence of phytoconstituents, as depicted in Table 1. The research findings indicate that the plant species being studied do not possess anthraquinones.

Table 1. Fagonia arabica qualitative phytochemical investigation from the inland desert (north section of the Eastern Desert).

Plant sample	Screening test								
	Alkaloids	Flavonoids	Phenols	Saponins	Tannins	Steroids	Glycosides	Anthraquinones	Terpenes
Fagonia arabica	+++	+++	++	+++	++	+	+	-	-

3.2. Quantitively analysis of Some Secondary metabolites

Phytochemistry, a field concerned with the chemical composition of plants and their many constituents, is widely acknowledged as an early subdivision of organic chemistry. The characterization and discovery of plant-derived compounds with medicinal properties have considerable importance [23]. The detailed evaluation of the analytical results pertaining to *F. arabica* revealed the unique attributes of the investigated plant, along with the diversified assortment of phytoconstituents that exhibited differences across different plant samples. Moreover, the examination revealed that the plant under investigation demonstrated a substantial presence of saponins, tannins, phenols, flavonoids, and alkaloids. The medicinal effects of many chemical classes, such as alkaloids, saponins, tannins, anthraquinones, and flavonoids, have been acknowledged for their efficacy against numerous diseases. Thus, these substances have historically been utilized for the management of many medical conditions, as evidenced by the investigations undertaken by Hassan et al. [24] and Usman and Osuji [25].

3.3. Antioxidant assay

Protecting human cells from oxidative stress is a major function of antioxidants, which also reduces the risk of getting cancer [26]. *Fagonia arabica* MeOH-extract was tested for its antioxidant properties by comparing it to catechol in its ability to quench DPPH free radicals. The scavenging effects of plant extracts and the standard were compared using the half maximum inhibitory concentration

(IC_{50}) values. Figure 1 shows the outcomes. Reduced IC_{50} values indicate increased DPPH radical scavenging efficiency. The data then showed that the extract obtained from the aboveground portions has the strongest antioxidant scavenging action (IC_{50} = 58.62 mg/L), proving the hypothesis. However, it is important to note that at concentrations higher than the IC_{50} value of 19.07 mg/ml, this activity is greater than that of catechol. Findings reported by Abd-ElGawad et al. [27], Cornara et al. [28], and Leonti [29] are consistent with the current findings about *Fagonia arabica*.

The objective of this study is to investigate and compare the antioxidant activity of the shoot extract of *Fagonia arabica* with other extracts obtained from wild plants originating from different geographical regions. Several studies have presented findings suggesting that the antioxidant capabilities of plants are controlled by the quantity of bioactive compounds, namely phenolic constituents such flavonoids, phenolic acids, ascorbic acid, and carotenoids [30]. Based on our research findings, it has been observed that this specific plant exhibits the presence of nonvolatile compounds such as tannins, flavonoids, and phenolics.

Table 2. Active organic compounds (mg g^{-1} dry wt.) of *Fagonia arabica* collected from the inland desert.

Plant sample	Active organic compounds				
	Alkaloids	Flavonoids	Phenols	Saponins	Tannins
Fagonia arabica	13.58±0.66	17.06±0.82	21.55±1.41	24.71±1.55	36.92±2.34

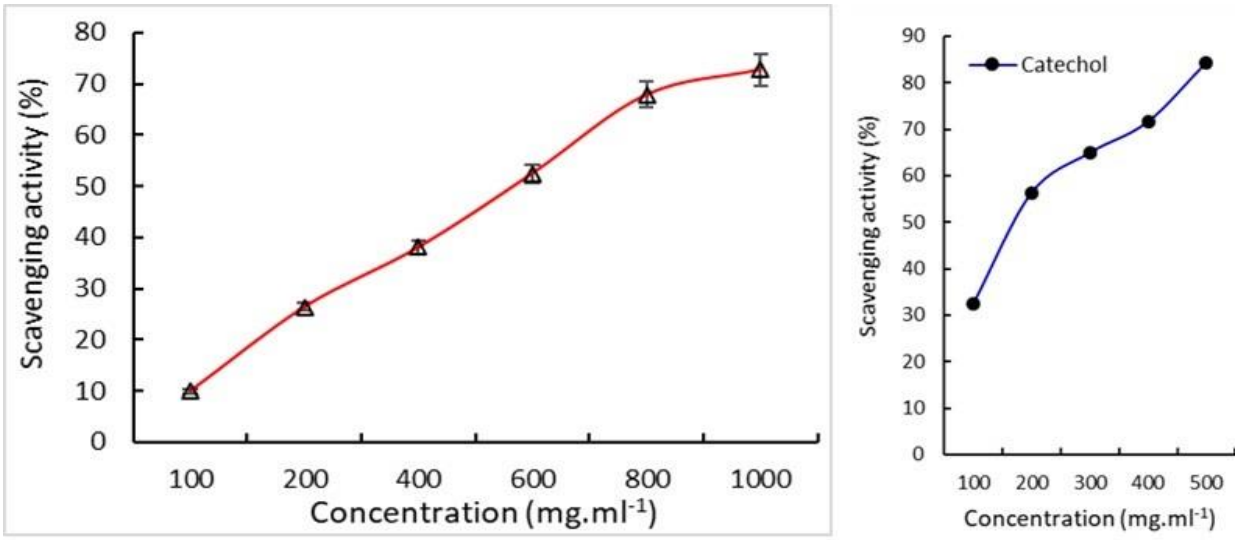

Figure 1. MeOH extract of *Fagonia arabica* taken from the Egyptian desert and catechol as standard for DPPH scavenging activity.

4. Conclusion

The data given in this study offers evidence in favor of utilizing specific plant extracts. The botanical taxonomy, the process of extraction, and the methodology for assessment jointly influence the properties of the bioactive compounds found in botanical samples. There exists a strong correlation between the antioxidant capabilities and bioactive substances, suggesting that the bioactive compounds are the primary contributors to the notable antioxidant qualities displayed by these plants. The findings present an opportunity for further exploration into the medicinal potential of various botanical species, as well as the determination of an appropriate solvent for the extraction of economically viable bioactive chemicals.

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