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Secondary metabolites of four wild medicinal Egyptian plants

*Wisam Elshamery, Ghada A. El-Sherbeny, Ibrahim A. Mashaly, and Mohamed Abdelaal**

Botany Department, Faculty of Science, Mansoura University, Mansoura 35516, Egypt

*** Correspondence to:** Email: mohamed_eco@mans.edu.eg, Tel: 01117370673

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Abstract : This study presents a comparative analysis of the phytochemical constituents and associated bioactivities of four medicinal plants: *Aerva javanica* (Burm.f.) Juss. ex Schult., *Deverra tortuosa* (Desf.) DC., *Trichodesma africanum*(L.) Sm., and *Erodium gruinum* (L.) L'Hér. Quantitative profiling of secondary metabolites revealed that *A. javanica* exhibited the highest levels of total phenols (210.40 mg GAE/g) and flavonoids (75.19 mg CE/g), followed by *D. tortuosa*. Conversely, *E. gruinum* showed the highest tannin content (10.50 mg TAE/g), suggesting potential astringent and antioxidant roles. Antioxidant capacity, assessed by DPPH (IC_{50}) and ABTS assays, indicated superior radical scavenging in *A. javanica* (IC_{50} = 0.129 mg/ml, ABTS = 76.8%), outperforming the standard ascorbic acid (IC_{50} = 0.022 mg/ml). Antibacterial activity, evaluated by inhibition zone diameters, revealed that *D. tortuosa* was most effective against *S. aureus* and *A. javanica* against *E. coli*. In vitro anticancer screening against HepG2, MCF-7, and PC3 cell lines showed that *A. javanica* had the lowest IC_{50} values (45.6, 50.2, and 48.94 µg/ml, respectively), highlighting its potential as a multi-target anticancer agent. The variations in bioactivity correlated significantly with concentration of bioactive constituents. These findings underscore the therapeutic potential of these desert plants and advocate for their further exploration in drug discovery and natural product research.

Keywords: Xerophytes, total phenols, solvent, anticancer, antioxidant.

1.Introduction

Because of their bioactive components, medicinal plants are essential to both conventional medicine and drug development. In order to combat environmental stressors, xerophytes—plants that have adapted to arid conditions—accumulate secondary metabolites, which makes them important sources of antibacterial and antioxidant compounds. To withstand harsh environments including high salt, water scarcity, and extreme temperatures, xerophytic plants have evolved unique metabolic pathways. Bioactive substances with considerable therapeutic efficacy are frequently produced as a result of these modifications. Secondary metabolites with anti-inflammatory, antibacterial, and antioxidant qualities include terpenoids, alkaloids, flavonoids, and tannins [1]. The need for thorough research on xerophytic plants as possible sources of novel medications is highlighted by the rising demand for natural medicinal agents worldwide.

Although *Trichodesma africanum*, *Erodium gruinum*, *Aerva gavanica*, and *Deverra tortuosa* have been utilized traditionally in Egypt for a variety of illnesses, little is known about their phytochemical and biological capabilities. In traditional medicine, *A. gavanica* has been used to treat digestive issues, wounds, and inflammation [2]. According to reports, *A. gavanica's* high flavonoid and alkaloid content gives it anti-inflammatory and antibacterial qualities [2]. From this plant, a variety of chemical components have been identified, including steroids, triterpenes, lipids, flavonoids, tannins, saponins, alkaloids, sulphates, sugars, and glycosides. The plant's medicinal benefits in reducing kidney stone pain and swelling have led to its widespread use. Gonorrhea, skin diseases, and dysentery are treated with the plant decoction. *Trichodesma africanum* has been reported to possess wound-healing properties and is traditionally used to manage

fever and skin infections [3]. *T. africanum* has demonstrated potential anticancer and antimicrobial properties, largely attributed to its alkaloids and tannins [3]. The objective of this was to determine the secondary metabolites of these four Egyptian medicinal plants.

2. Materials and methods

2.1 Plant collection and preparation

Samples of plants were gathered from Wadi Hagoul in Egypt's Eastern Desert in April and May of 2024. According to [4,5,6], the last author was responsible for identifying these plants. Each plant's voucher specimens were stored in Mansoura University's herbarium, where they were allowed to air dry at ambient temperature. For extraction, the dried substance was finely powdered. To identify secondary metabolites, methanol was combined with powdered samples of four plants that had been aerially dried. The samples were kept for four hours at 200 rpm in a water-bath shaker at a lowered temperature of 40°C. Filter paper No. 1 was used to filter the extracts, which were then vacuum-evaporated and kept at 5°C.

2.2. Phytochemical analysis

The Folin-Ciocalteu test was used to measure the total phenols [8]. The aluminum chloride test was used to assess the flavonoid content [9]. The vanillin-hydrochloride method was used for tannins [10]. An ammonium hydroxide solution was used to quantify the amount of alkaloids (mg g^{-1} dry extract). Using successive solvent extractions, the amount of saponins (mg g-1 dry extract) was calculated [4].

2.3. Antioxidant activity

Both DPPH [11] and (ABTS+) [12] assays were used to investigate the antioxidant scavenging activity of the methanol extracts of the chosen medicinal plants.

2.4. Anticancer activity

Three human tumor cell lines: HePG2, MCF-7, and PC3 were used in the current study. The colorimetric assay of MTT to test the anticancer activity of selected plants.

3. Results

3.1. Secondary metabolites

Quantitative estimation of secondary metabolites revealed significant interspecific variation among the four studied medicinal plants **(Figure 1)**. *A. javanica* recorded the highest total phenolic content (210.40 ± 1.12 mg GAE/g DW) and flavonoid content (75.19 ± 2.03 mg CE/g DW), suggesting a superior antioxidant capacity. *D. tortuosa* showed moderate levels of phenolics (180.22 ± 2.68 mg GAE/g) but had the highest saponin content (2.31 ± 0.09%). In contrast, *T. africanum* exhibited a lower total phenolic content (89.90 ± 1.71 mg GAE/g) but contained a moderate level of alkaloids (7.16 ± 1.09%), *E. gruinum* had the highest tannin content (10.50 ± 0.34 mg TAE/g).

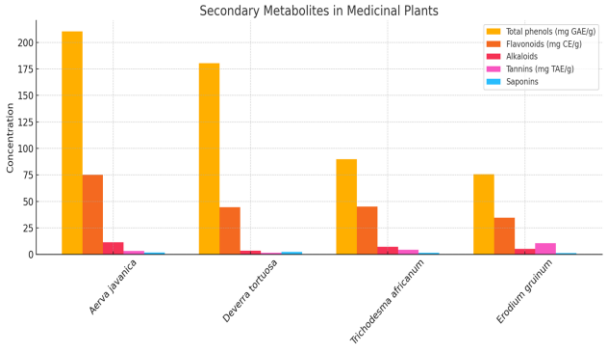

Figure 1. Concentration of secondary metabolites (mg/ g) in the studied four medicinal plants.

3.2. Antioxidant activity

The antioxidant activity, evaluated by DPPH radical scavenging assay (IC_{50} values) and ABTS inhibition, confirmed that *A. javanica* had the highest antioxidant potential (IC_{50} = 0.129 mg/mL; ABTS inhibition = 76.8%). *D. tortuosa* also exhibited strong antioxidant performance (IC_{50} = 0.169 mg/mL), likely attributed to both phenolics and saponins. Meanwhile, *T. africanum* and *E. gruinum* displayed relatively weaker antioxidant activities (IC_{50} = 0.653 and 0.877 mg/mL, respectively), consistent with their lower total phenolic contents.

3.3. Anticancer activity of the studied plants

The anticancer assays against HepG2, MCF-7, and PC3 cell lines showed that *A. javanica* exerted the most potent cytotoxic activity (IC_{50} = 45.6, 50.2, and 48.94 µg/mL, respectively). In contrast, *E. gruinum* showed the weakest cytotoxic effect, particularly against MCF-7 (IC_{50} = 95.4 µg/mL), despite its high tannin concentration **(Figure 2)**.

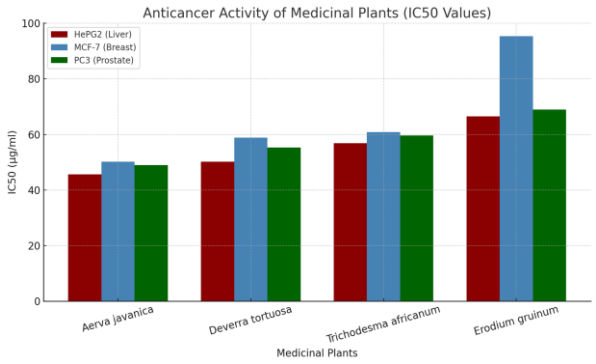

Figure 2. Anticancer activity of four medicinal plants against three cell lines (HepG2, MCF-7 and PC3).

4. Discussion

Quantitative estimation of secondary metabolites revealed significant interspecific variation among the four studied medicinal plants. These findings align with previous reports highlighting the rich polyphenolic reservoir in *Aerva* species and their antioxidant potential [14, 15]. Saponins are known for their surfactant and antimicrobial properties, potentially contributing to the plant's bioactivity [16]. In contrast, *T. africanum* exhibited a lower total phenolic content but contained a moderate level of alkaloids, suggesting possible analgesic or neuroactive potentials [17]. *E. gruinum* had the highest tannin content, which is often linked to astringent, antimicrobial, and antioxidant functions [18].

The antioxidant activity, evaluated by DPPH radical scavenging assay (IC_{50} values) and ABTS inhibition, confirmed that *A. javanica* had the highest antioxidant potential. This strong activity correlates with its elevated phenolic and flavonoid concentrations, which are widely reported to confer radical scavenging activity by donating electrons or hydrogen atoms (Rice-Evans et al., 1997; Prior et al., 2005). *D. tortuosa* also exhibited strong antioxidant performance, likely attributed to both phenolics and saponins. Meanwhile, *T. africanum* and *E. gruinum* displayed relatively weaker antioxidant activities, consistent with their lower total phenolic contents.

The anticancer assays against HepG2, MCF-7, and PC3 cell lines showed that *A. javanica* exerted the most potent cytotoxic activity. The observed cytotoxicity may be linked to its high flavonoid and phenolic content, which are known to modulate pathways such as apoptosis, ROS generation, and cell cycle arrest (Surh, 2003; Ren et al., 2003). In contrast, *E. gruinum* showed the weakest cytotoxic effect, particularly against MCF-7 despite its high tannin concentration. This suggests that not all polyphenolics confer cytotoxicity, and that compound-specific mechanisms may be at play.

5. Conclusion

Collectively, the data underscore the therapeutic potential of *Aerva javanica*, which emerged as the most promising species across all bioactivity parameters. *Deverra tortuosa* followed, particularly in antimicrobial efficacy. The correlation between phytochemical abundance and biological activities suggests that phenolic and flavonoid content are critical determinants of antioxidant and anticancer properties, while saponins and alkaloids contribute significantly to antibacterial action.

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