GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(REVIEW ARTICLE)

Check for updates

Pharmacology of the species Equisetum (*Equisetum arvense*)

Raghda Makia [1,*], Khulood W Al sammarrae [2], Mohammad MF Al Halbosiy [3] and Mohammed H Al Mashhadani [4]

[1] *Biotechnology College, Al-Nahrain University, Baghadad, Iraq.*
[2] *Department of Forensic Techniques, Al-Farahidi University, Baghadad, Iraq.*
[3] *Biotechnology Research Center, Al-Nahrain University, Baghadad, Iraq.*
[4] *Department of Chemistry, College of Science, Al-Nahrain University, Baghdad, Iraq.*

GSC Biological and Pharmaceutical Sciences, 2022, 18(02), 290–294

Publication history: Received on 01 January 2022; revised on 08 February 2022; accepted on 10 February 2022

Article DOI: https://doi.org/10.30574/gscbps.2022.18.2.0060

Abstract

The greater *Equisetum arvense* is an herbaceous plant from the family Equisetaceae commonly found in North America, Europe and Asia. The plant has been used since ancient times in medical practice because of its pharmacological applications, and the presence of many biologically active compounds, including flavonoids, alkaloids, carbohydrate, proteins and amino acids, phytosterols, saponins and sterols. Scientific data reveals the existence of 0.6 to 0.9% flavonoids including apigenin glucoside, genkwanin glucoside, kaempferol glucoside, kaempferol sophoroside, luteolin glucoside, quercetin glucoside. It also contained caffeic acid, 5-7.7% silicic acid and alkaloids.

Keywords: Kaempferol glucoside; Equisetum; Amino acids; Pharmacology; Saponins

1. Introduction

Searching for antitumor agents is the most intensive segment in the development of new drugs. Modern approach to the research focused on finding compounds which affect important processes in tumor development, progression and metastasis. Very important source of new drugs represents bioactive components of natural products. Nowadays, plants are known as a rich source of compounds with antioxidative and immunomodulatory properties [1]. Description and medicinal uses of *Equisetum arvense* are monographed in the European Pharmacopoeia and in a national pharmacopoeia, and reported in well-established documents. A number of pharmacological properties, e.g. anti-inflammatory [2], antioxidant [3], Antileishmanial [4], antimicrobial [5], Anti-platelet aggregation [6], Cytotoxic and anticarcinogenic [7] have been reviewed and supported by clinical data. By virtue of these properties *E. arvense* is widely used in alternative medicine to treat liver diseases, eases the pain of rheumatism and stimulates the healing of chilblains, benefit for cardiovascular problems, stop bleeding, heal ulcers and wounds, treat tuberculosis and kidney problems [8-9-10-11]. Antitumor actions of this plant have been studied in many *in vitro* and *in vivo* experiments. Also, a few clinical trials suggested beneficial effect of *E. arvanse* in the management of human cancer [11-12-13-7].

2. Pharmacological activity of *Equisetum arvense*

Several studies have described different biological effects of *Equisetum arvense* L. extract or tea with natural extract, such as antioxidant, anti-inflammatory, antibacterial, antifungal, vasorelaxant, neuro and cardio protectors [14-10] and antiproliferative properties [11-15].

* Corresponding author: Raghda Makia
Biotechnology College, Al-Nahrain University Baghadad, Iraq.

2.1. Anti-inflammatory

Equisetum arvense have anti-inflammatory properties for the treatment of wounds or inflammatory diseases such as arthritis have been described [16-17]. However, to date, there are no studies on the impact of *Equisetum arvense* extracts on lymphocytes involved in inflammatory immune processes. Lymphocytes are the body's second line of defense and T cells are actively recruited to sites of inflammation where they maintain and activate fibroblasts or bystander dendritic cells and macro-phages, transforming them into tissue-destructive effector cells [18]. T- lymphocytes are the dominant cells in inflammatory immune diseases [19-20], and their proliferation and mediator release (IFN-γ, TNF-α) are targets for modern therapies [21]. Immunosuppressants such as glucocorticoids [22] or calcineurin inhibitors, e.g., cyclosporine A, which specifically down-regulate the immune system [21], are the established treatment of choice. Despite the availability of effective conventional medications, approximately 60-90% of patients with inflammatory immune disorders re-sort to alternative or complementary therapies to avoid side effects [23].

2.2. Antimicrobial activity

Worldwide, research has shown an increased interest in the phytochemical products of *E. arvense*, due to its various biological effect such as cytotoxicity, antibacterial, anticandidal potentials and treatment of many diseases [24]. Several studies have demonstrated that phytochemical compounds of *Equisetum arvense* L. are flavonoids, phenolic acids, alkaloids, phytosterols, tannins, triterpenoids saponins, aconite, oxalic and malic acid, resins, pectin, vitamin C, carotenoids and mineral substances [25-5]. Several studies have shown that polyphenols from *E. arvense* can be an alternative to antibiotics against microbial pathogens [26] and overcome to various microbial infections that associated with antibiotic failure, form biofilm, both are require more active of biochemical agents with complementary action or synergic effect with antibiotherapy. Starting from the previously obtained results, were shown The alcoholic and aqueous extracts of the aerial parts of *Equisetum arvense* displayed antibacterial activity against *Escherichia coli*, *Staphylococcus epidermidis , Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Salmonella enteritidis* and anti-candida activity property against Candida species, such as *C. albicans, C. glabrata, C.* Using disc diffusion technique. The mean inhibition zone of *Equisetum arvense* extract against Gram positive and Gram negative bacteria increased with the increasing concentration of the extract. The highest mean zone of inhibition 32 mm was recorded against *Escherichia coli* [27]. [28]evaluated the antibacterial activity of *Equisetum arvense* on urinary tract pathogens such as *Klebsiella pneumonia, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus and Staphylococcus saprophyticus* by disc diffusion technique concentrations 250, 500 and 1000 µg/disc. The inactivated effects of *Equisetum arvense* against many microbes due to its composition rich with an essential oil which inactivated the microbial adhesion proteins and transport proteins and induced the rupture in the membrane of microbes [29]. In addition, the phenolic compounds in the plant extracts reduced the generation of ROS which induced by bacterial lipopolysaccharides or *Candida albicans* due to trapping free radicals directly or scavenging ROS by reactions with antioxidant enzymes [30]. Moreover, the alcoholic extract was found to be more effective than chloroform extracts, other hand, the extract prepared from plant from the summer season was more effective than from winter season [31]. Significant higher cytotoxic activity and antimicrobial activity capacity were processed with either extraction medium containing 90% ethanol for 12 hours, or ethanol 80% of *Equisetum arvense* [32].

2.3. Antioxidant or free radical scavenger

Equisetum arvense extract possess free radical scavenging activity. So, it acts as an antioxidant. Water extract and ethanol extract from top and body portions of field horsetail (tsukushi) were prepared and the antioxidative activity was investigated 8. The scavenger activity of *E. arvense, E. romosissimum,* and *E. telmateia* aboveground parts phosphate buffer (pH 7) extracts were evaluated using three different methods: DPPH assay, ESR and NO radical inhibition assay.

Total reducing power was determined by FRAP assay. The free radical scavenging activity of some Mongolian herbs was also carried out using electron spin resonance (ESR) spectrometer and chemiluminescence (CL) analyzer [33].

3. Immunomodulatory activity

3.1. Anticancer

Plants and plant-derived compounds have been used since ages as a major source for treating diseases in human [34]. Considering their high efficacy and low side effects, they have become the first priority of pharmaceutical industries. Therefore, there is a growing demand for screening plant-derived compounds against many complicated diseases, including cancer, diabetes, and obesity and so on. Hence, for the treatment of disease states, wherein drug therapy is a rational approach, plant materials represent legitimate starting materials for the discovery of new agents. In the case of human cancers, thus far, nine plant-derived compounds have been approved for clinical use as anticancer drugs in the

United States [35]. However, still, most of the patients treated for cancer die from its treatment. Therefore, there is need of development of new and effective anticancer drugs. Nevertheless, there are many plant-derived anticancer drugs currently used for the treatment of cancer [36]. *Equisetum arvense* [horsetail] is widely used in Saudi Arabia for generations as a traditional medicine for kidney related disorders, diuretics, gastroenteritis and urinary infections. The plant belongs to family Equisetaceae and has been used throughout the world, particularly, in the Middle East, Canada, Europe, and some Asian countries [37]. In this study, the Anticancer, antidiabetic and antibacterial activities ethanolic extract of *Equisetum arvense* was evaluated.

3.2. Toxic potential

Tens of thousands of plant species are used medicinally [38] and a substantial portion of the world's population depends on traditional medicine. In recent decades, public interest in herbal products has grown [39-39-41] but these products are not always regulated. The safety of herbal products can be compromised through accidental adulteration, misidentification and deliberate contamination [42-43] which can lead to severe side effects due to the presence of toxic compounds [44].

Preclinical studies have revealed various pharmacological actions of *Equisetum arvense*, including antioxidant [9-45] and antidiabetic [46-47] properties, but no acute hepatotoxicity [48]. The health regulatory agencies of the Federal Republic of Germany established the German Commission E in 1974. This commission approved the use of *Equisetum arvense* for the treatment of posttraumatic and static edema and as a diuretic for bacterial and inflammatory diseases of the urinary tract presenting with urinary sediment [49]. Topical use as an adjuvant for the treatment of wounds that exhibit difficult healing has been reported [1-50]. However, *E. arvense* does not satisfy the requirements as a well-established medicine, despite an ancient tradition of use because clinical studies of its effects on renal function and safety are lacking. The "Assessment of Medicinal Products for Human Use" of the European Medicines Agencies concluded that clinical data on the absorption, distribution, and pharmacokinetics of *Equisetum arvense* are scarce or completely lacking [49-51].

4. Conclusion

The paper reviewed *Equisetum arvense* as promising medicinal plant with wide range of pharmacological activities which could be utilized in several medical applications because of its effectiveness and safety.

Compliance with ethical standards

Acknowledgments

We would like to thank Al-Nahrain University for their support during this work.

Disclosure of conflict of interest

All authors of the manuscript have no conflict of interests to declare.

References

[1] Carneiro DM, Freire RC, Honório TCDD, Zoghaib I, Cardoso FFDS, Tresvenzol LMF, Cunha LCD. Randomized, double-blind clinical trial to assess the acute diuretic effect of *Equisetum arvense* (field horsetail) in healthy volunteers. Evidence-Based Complementary and Alternative Medicine. 2014.

[2] Gründemann C, Lengen K, Sauer B, Garcia-Käufer M, Zehl M, Huber R. *Equisetum arvense* (common horsetail) modulates the function of inflammatory immunocompetent cells. BMC complementary and alternative medicine. 2014; 14(1): 1-10.

[3] Huh MK, Han MD. Inhibitory effect of hyaluronidase and dpph radical scavening activity using extraction of equisetum arvens. European Journal of Advanced Research in Biological and Life Sciences. 2015; 3(2).

[4] Saeed BQ, Hassan HF, Arteen HI. Effect of Some Medical Plant Extracts on Metabolism of Leishmania tropica Promastigotes. J Med Microb Diagn. 2014; 3(165): 2161-0703.

[5] Garcia D, Ramos AJ, Sanchis V, Marín S. *Equisetum arvense* hydro-alcoholic extract: phenolic composition and antifungal and antimycotoxigenic effect against Aspergillus flavus and Fusarium verticillioides in stored maize. Journal of the Science of Food and Agriculture. 2013; 93(9): 2248-2253.

[6] Mekhfi H, El Haouari M, Legssyer A, Bnouham M, Aziz M, Atmani F, Ziyyat A. Platelet anti-aggregant property of some Moroccan medicinal plants. Journal of ethnopharmacology. 2004; 94(2-3): 317-322.

[7] Al Mohammed I, Paray BA, Rather IA. Anticancer activity of EA1 extracted from *Equisetum arvense*. Pak. J. Pharm. Sci. 2017; 30(5): 1947-1950.

[8] Mori S, Okano Y, Masaki H. Inhibitors of lipase produced by microorganisms for pharmaceuticals and cosmetics. Jpn Kokai Tokkyo Koho. 2002; 5.

[9] Mimica-Dukic N, Simin N, Cvejic J, Jovin E, Orcic D, Bozin B. Phenolic compounds in field horsetail (*Equisetum arvense* L.) as natural antioxidants. Molecules. 2008; 13(7): 1455-1464.

[10] Sandhu NS, Kaur SARABJIT, Chopra DIVNEET. *Equisetum arvense*: pharmacology and phytochemistry-a review. Asian journal of pharmaceutical and clinical research. 2010; 3(3): 146-150.

[11] Četojević-Simin DD, Čanadanović-Brunet JM, Bogdanović GM, Djilas SM, Ćetković GS, Tumbas VT, Stojiljković B T. Antioxidative and antiproliferative activities of different horsetail (*Equisetum arvense* L.) extracts. Journal of medicinal food. 2010; 13(2): 452-459.

[12] Alexandru V, Petrusca DN, Gille E. Investigation of pro-apoptotic activity of *Equisetum arvense* L. water extract on human leukemia U 937 cells. Romanian Biotechnological Letters. 2007; 12(2): 3139.

[13] Aldaas S. Cytotoxic and antibacterial activity of an extract from a Saudi traditional medicinal plant *Equisetum arvense* (Doctoral dissertation). 2011.

[14] Dos Santos Jr JG, Blanco MM, Do Monte FHM, Russi M, Lanziotti VMNB, Leal LKAM, Cunha GM. Sedative and anticonvulsant effects of hydroalcoholic extract of *Equisetum arvense*. *Fitoterapia*. 2005; *76*(6): 508-513.

[15] Yamamoto Y, Inoue T, Hamako J. Crude proteins extracted from *Equisetum arvense* L. increases the viability of cancer cells in vivo. Seibutsu Shiryo Bunseki. 2004; 27(5): 409-412.

[16] Costa-Rodrigues J, Carmo SC, Silva JC, Fernandes, MHR. Inhibition of human in vitro osteoclastogenesis by E quisetum arvense. Cell proliferation. 2012; 45(6): 566-576.

[17] Do Monte FHM, dos Santos Jr JG, Russi M, Lanziotti VMNB, Leal LKAM, de Andrade Cunha GM. Antinociceptive and anti-inflammatory properties of the hydroalcoholic extract of stems from *Equisetum arvense* L. in mice. Pharmacological research. 2004; 49(3): 239-243.

[18] Choy EH, Panayi GS. Cytokine pathways and joint inflammation in rheumatoid arthritis. New England Journal of Medicine. 2001; 344(12): 907-916.

[19] Berner B, Wolf G, Hummel KM, Müller GA, Reuss-Borst MA. Increased expression of CD40 ligand (CD154) on CD4+ T cells as a marker of disease activity in rheumatoid arthritis. Annals of the rheumatic diseases. 2000; 59(3): 190-195.

[20] Cai Y, Fleming C, Yan J. New insights of T cells in the pathogenesis of psoriasis. Cellular & molecular immunology. 2012; 9(4): 302-309.

[21] Macian F. NFAT proteins: key regulators of T-cell development and function. Nature Reviews Immunology. 2005; 5(6): 472-484.

[22] Rhen T, Cidlowski JA. Antiinflammatory action of glucocorticoids—new mechanisms for old drugs. New England Journal of Medicine. 2005; 353(16): 1711-1723.

[23] Rao JK, Mihaliak K, Kroenke K, Bradley J, Tierney WM, Weinberger M. Use of complementary therapies for arthritis among patients of rheumatologists. Annals of internal medicine. 1999; 131(6): 409-416.

[24] Augustyniak A, Bartosz G, Čipak A, Duburs G, Horáková LU, Łuczaj W, Žarković N. Natural and synthetic antioxidants: an updated overview. Free radical research. 2010; 44(10): 1216-1262.

[25] Radulović N, Stojanović G, Palić R. Composition and antimicrobial activity of *Equisetum arvense* L. essential oil. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 2006; 20(1): 85-88.

[26] Wu LC, Hsu HW, Chen YC, Chiu CC, Lin YI, Ho JAA. Antioxidant and antiproliferative activities of red pitaya. Food chemistry. 2006; 95(2): 319-327.

[27] Sinha SN. *In vitro* antibacterial activity of ethanolic extract of *Equisetum arvense* L. *Indian Journal of Pharmaceutical and Biological Research*. 2012; *3*(1): 19-21.

[28] Geetha RV, Lakshmi T, Roy A. In vitro evaluation of antibacterial activity of *Equisetum arvense* Linn on urinary tract pathogens. International Journal of Pharmacy and Pharmaceutical Sciences. 2011; 3(4): 323.

[29] Alavarce RA, Saldanha LL, Almeida NLM, Porto VC, Dokkedal AL, Lara VS. The beneficial effect of Equisetum giganteum L. against Candida biofilm formation: new approaches to denture stomatitis. Evidence-Based Complementary and Alternative Medicine. 2015.

[30] Oh H, Kim DH, Cho JH, Kim YC. Hepatoprotective and free radical scavenging activities of phenolic petrosins and flavonoids isolated from *Equisetum arvense*. Journal of Ethnopharmacology. 2004; 95(2-3): 421-424.

[31] Ajay K, Purshotam K. Antibacterial effect of *Equisetum arvense* L. Asian Journal of Bio Science. 2011; 6(2): 184-187.

[32] Milovanović V, Radulović N, Todorović Z, Stanković M, Stojanović G. Antioxidant, antimicrobial and genotoxicity screening of hydro-alcoholic extracts of five Serbian Equisetum species. Plant Foods for Human Nutrition. 2007; 62(3): 113-119.

[33] Myagmar, B. E., & Aniya, Y. (2000). Free radical scavenging action of medicinal herbs from Mongolia. Phytomedicine, 7(3), 221-229.

[34] Ramawat, K. G., & Mérillon, J. M. (2008). Bioactive molecules and medicinal plants (pp. 22-18). Berlin: Springer.

[35] Wang, J., Jiang, W., & Wang, Y. (2013). Anti-inflammation of flavonoid compounds from Dalbergia odorifera T. Chen in lipopolysaccharide stimulated RAW264. 7 macrophages. Xi bao yu fen zi mian yi xue za zhi= Chinese journal of cellular and molecular immunology, 29(7), 681-684.

[36] Da Rocha, A. B., Lopes, R. M., & Schwartsmann, G. (2001). Natural products in anticancer therapy. Current opinion in pharmacology, 1(4), 364-369.

[37] Asgarpanah, J., & Roohi, E. (2012). Phytochemistry and pharmacological properties of *Equisetum arvense* L. Journal of Medicinal Plants Research, 6(21), 3689-3693.

[38] Schippmann U, Leaman DJ, Cunningham AB. Impact of cultivation and gathering of medicinal plants on biodiversity: global trends and issues. Biodiversity and the ecosystem approach in agriculture, forestry and fisheries. 2002.

[39] Kennedy J. Herb and supplement use in the US adult population. Clinical therapeutics. 2005; 27(11): 1847-1858.

[40] Marinac JS, Buchinger CL, Godfrey LA, Wooten JM, Sun C, Willsie SK. Herbal products and dietary supplements: a survey of use, attitudes, and knowledge among older adults. Journal of Osteopathic Medicine. 2007; 107(1): 13-23.

[41] Jordan SA, Cunningham DG, Marles RJ. Assessment of herbal medicinal products: challenges, and opportunities to increase the knowledge base for safety assessment. Toxicology and applied pharmacology. 2010; 243(2): 198-216.

[42] Ernst E. Risks of herbal medicinal products. Pharmacoepidemiology and drug safety. 2004; 13(11): 767-771.

[43] Van Breemen RB, Fong HH, Farnsworth NR. Ensuring the safety of botanical dietary supplements. The American journal of clinical nutrition. 2008; 87(2): 509S-513S.

[44] Gilbert N. Regulations: Herbal medicine rule book. Nature. 2011; 480(7378): S98–S99.

[45] Štajner D, Popović BM, Čanadanović-Brunet J, Boža P. Free radical scavenging activity of three Equisetum species from Fruška gora mountain. Fitoterapia. 2006; 77(7-8): 601-604.

[46] Safiyeh S, Fathallah FB, Vahid N, Hossine N, Habib SS. Antidiabetic effect of *Equisetum arvense* L.(Equisetaceae) in streptozotocin-induced diabetes in male rats. Pakistan journal of biological sciences: PJBS. 2007; 10(10): 1661-1666.

[47] Soleimani S, Azarbaizani FF, Nejati V. The effect of *Equisetum arvense* L.(Equisetaceae) in histological changes of pancreatic beta-cells in streptozotocin-induced diabetic in rats. Pakistan journal of biological sciences: PJBS. 2007; 10(23): 4236-4240.

[48] Baracho NCDV, Vicente BBV, Arruda GD, Sanches BCF, Brito JD. Study of acute hepatotoxicity of *Equisetum arvense* L. in rats. Acta Cirurgica Brasileira. 2009; 24: 449-453.

[49] Blumenthal M. The complete German commission E monographs. Therapeutic guide to herbal medicines. 1999.

[50] Del Fresno MVÁ, Peinado II. Equisetum: pharmacology and pharmacotherapy. Farmacia Profesional. 2006; 20(2): 74-77.

[51] Wright CI, Van-Buren L, Kroner CI, Koning MMG. Herbal medicines as diuretics: a review of the scientific evidence. Journal of ethnopharmacology. 2007; 114(1): 1-31.