

EQUIETUM ARVENSE: PHARMACOLOGY AND PHYTOCHEMISTRY - A REVIEW

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ABSTRACT

Equisetum arvense commonly known as field horsetail is a plant with wide prospectus. In folk medicine, *Equisetum arvense* is used for tuberculosis, as a catarrh in the kidney and bladder regions, as a hemostatic for profuse menstruation, nasal, pulmonary and gastric hemorrhages, for brittle fingernails and loss of hair, for rheumatic diseases, gout, poorly healing wounds and ulcers, swelling and fractures and for frostbite (PDR for herbal medicines). The plant is reported to contain a number flavonoids, alkaloids, minerals, phenolic petrosins, triterpenoids, saponins, phytosterols. The present review is an attempt to generate interest among the masses regarding its immense potential in preventing and treating several disorders.

Key words: *Equisetum arvense*, Common horsetail, Pharmacology.

INTRODUCTION

The genus *Equisetum* consists are 30 species of rush like, conspicuously jointed, perennial herbs. *Equisetum* is the only living genus of the order Equisetales and the class Sphenopsida. *Equisetum arvense*, commonly known as the Field Horsetail or Common Horsetail, is a bushy perennial herb native to the northern hemisphere. It is a member of a very primitive family of plants. In spring a spore-bearing stem, resembling a thin asparagus shoot, rises 15-20cm; once shed, this is replaced by a pale green bush with erect hollow jointed stems with longitudinal furrows, and with sharply-toothed sheaths covering each joint; from the sheaths of the central stem arise whorls of fine branches, each giving off finer whorls, the whole sometimes extending up to 60 cm in height, but usually less^{1,2}.

PLANT DESCRIPTION OF COMMON HORSETAIL

Classification

Kingdom	<i>Plantae</i> - Plants
Subkingdom	<i>Tracheophyta</i>
Superdivision	<i>Pteridophytes</i>
Division	<i>Equisetophyta</i>
Class	Sphenopsida
Subclass	Equisetidae
Order	Equisetales
Family	Equisetaceae
Genus	<i>Equisetum</i> L.
Species	<i>arvense</i> L.

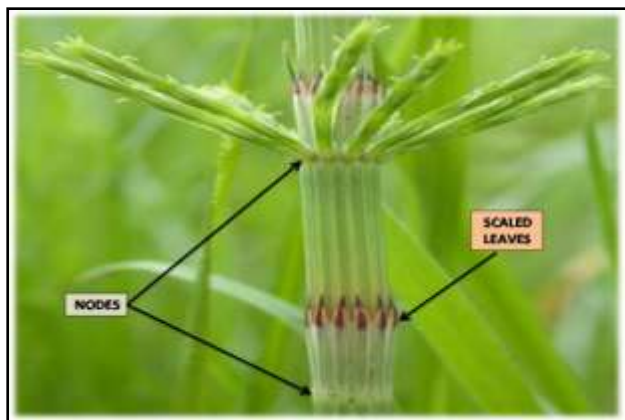


Figure 1: Horsetail plant

Horsetail (Figure 1) is a strange-looking sort of plant with creeping, string like rootstock and roots at the nodes that produce numerous

hollow stems. 2 markedly different types; Fertile stems unbranched, appear in early spring, usually thick and succulent, brownish to whitish, 10 - 30 cm tall. Sterile stems bottlebrush-like (many whorls of slender branches), appear as fertile stalks with 1-several in clusters, 10 - 50 cm tall; slender, green, 10 - 12 ridged, minutely-roughened; branches simple, first branch segment longer than adjacent stem sheath.

The sterile stems tend to be much taller and bushier, with the jointed segments being around one inch long with a diameter of about 1/20th of an inch. These segments contain one set of whorled, slender, erect branches each. Some stems can have as many as 20 segments and be as tall as 2-24 inches. The fertile stems tend to be half as tall as the sterile stems and also tend to be more succulent.

Leaves - Reduced to small scales, usually fused into sheaths around stems and branches; sheaths of fertile stems have 8 - 12 large, pointed teeth; sheaths of sterile stems green, with 10 - 12 brownish or blackish teeth.

Spore Clusters - In long-stalked, blunt-tipped cones at tip of fertile stems.

Other features - Very variable sometimes prostrate. Fertile stems brown, arising earlier than the sterile ones, not turning green but dying down after releasing spores

Parts used

Aerial parts are used mainly sterile spring stems³.

Collection

Mid to late summer.

Seasonality

Coning February (southerly locales) to July (far north). Mostly in April and May.

Ecology

Marshes, swamps, ditches, river banks, open fields, open woods, and fill areas, such as road sides, and railroad embankments⁴.

Distribution

Throughout Canada and the USA except the southeast (Florida, Georgia, Alabama, Louisiana, Mississippi, Tennessee). Throughout Europe and Asia south to Turkey, Iran, the Himalayas, and across China (except the southeastern part) Korea and Japan⁵.

PHARMACOLOGICAL ACTIVITIES

Anodyne

Equisetum arvense extract is used as a pain relieving agent. Horsetail has an antinociceptive and anti-inflammatory effect as evaluated in

mice by applying hydroalcoholic extract of horsetail to mice. The results indicate that this extract exhibits an antinociceptive effect in chemical models of nociception which is not related to the opioid system ⁶.

Anti-inflammatory

It is a widely used anti-inflammatory agent. Anti-inflammatory effect as evaluated in mice by applying hydroalcoholic extract of horsetail to mice. Due to its anti-inflammatory property it is used to treat arthritis, chilblains, cystitis, gout, inflammation of the lower urinary tract, renal gravel. It is considered as a specific remedy in cases of inflammation or benign enlargement of the prostate gland. The tea makes a good wash for wounds, sores, skin problems and a gargle for mouth and gum inflammations ⁶.

Antidiabetic

The methanolic extract of *Equisetum arvense* was analysed for its antidiabetic activity in streptozotocin induced diabetic rats. The results showed methanolic extract of *Equisetum arvense* produced a significant Antidiabetic activity at doses 50 and 250 mg/kg⁻¹/b.wt ⁷.

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 ⁹. The free radical scavenging activity of some Mongolian herbs was also carried out using electron spin resonance (ESR) spectrometer and chemiluminescence (CL) analyzer ¹⁰.

Antimicrobial

Essential oil of *Equisetum arvense* shows antimicrobial activity against wide range of strains. Bacteria: *S. aureus*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *S. enteritidis*; Fungi: *A. niger* and *C. albicans* ¹¹.

Anaemia

The juice of the plant is good for anaemia resulting from internal bleeding such as stomach ulcers, since it promotes the coagulation of blood. Because of its mineral content horsetail is recommended for anemia and general debility. It has platelet anti-aggregant property ¹².

Anti-haemorrhagic

The local astringent and antihemorrhagic effect explains the application of horsetail to such conditions as bleeding from the mouth, nose and vagina, its use to check diarrhoea, dysentery and bleeding from the bowel, and for slow-healing wounds, chilblains and conjunctivitis ¹³.

Astringent

Equisetum arvense is an excellent genito-urinary system astringent. It may be applied to such conditions as urethritis or cystitis with haematuria, reducing haemorrhagic and healing wounds thanks to the high silica content.

CNS effects

The research of influence at 5 plant collections on nervous system is carried out. They consist of *Equisetum arvense* (grass), *Galium verum* (grass), *Plantago major* (leaves), *Achillea millefolium* (grass), *Leonurus quinquelobatus* and/or *cardiaca* (grass), *Rubus caesius* (leaves), *Filipendula hexepetala* (flowers) and *Calendula officinalis* (flowers). The collection No1, consisting from a grass of *Equisetum arvense*, grass of *Galium verum*, leaves of *Plantago major*, grass of *Achillea millefolium* and grass of *Leonurus*, was the most active. It has the greatest synergism to barbiturates, more than others it increased barriers of emotional response at animals and also has the greatest anticonvulsive effect ¹⁴.

The hydroalcoholic extract of *Equisetum arvense* tested at doses of 200 and 400 mg/kg enhanced the number of falls in the rota-rod

reducing the time of performance in the bar and increased the sleeping time (46% and 74%) in the barbiturate-induced sleeping. In the pentylenetetrazole-seizure, it increased the first convulsion latency, diminished the severity of convulsions, and reduced the percentage of animals from death. Thus, HAE presented anticonvulsant and sedative effects ¹⁵.

The hydroalcoholic (HAE) extract of *Equisetum arvense* reverses the cognitive impairment in aged rats. Chronic administration of HAE at dose of 50mg/kg, i.p., improved both short- and long-term retention of inhibitory avoidance task and ameliorated the cognitive performance in reference and working memory version of the Morris water Maze ¹⁶.

Cosmetics

Wide range of skin and hair cosmetics contains *Equisetum arvense* extract. In skin cosmetics it acts as anti-aging, moisturizer, anti-wrinkle, anti-acne, antiperspirant, conditioner. It prevents grey hair, strengthen the hairs and maintain hair tone. Horsetail extract is also used as anti-dandruff agent ¹⁷.

Cancer

The water extract from sterile stems of *Equisetum arvense* L. has dose dependent cytotoxic effects on human leukemic U 937 cells. DNA fragmentation, externalization of phosphatidylserine, the collapse of mitochondrial transmembrane potential, was all observed in cells cultured for 48 h with the herb extract. Taken together these results suggest that the cytotoxicity of *Equisetum arvense* L. water extract against U 937 cells is due to apoptosis ¹⁸. From ancient times, the broth of Equisetaceae has been used in wet compresses and a variety of folk medicines. It has been reported that crude proteins extracted from *Equisetum arvense* L. inhibit the proliferation of cultured cancer cells ¹⁹.

Diuretic

Whilst it acts as a mild diuretic, its toning and astringent action make it of value in the treatment of incontinence and bed-wetting in children. As a diuretic it is particularly suited to metabolic or hormonal oedema during the menopause. It possesses a great capacity to eliminate water from the body; in such a point to increase urination up to 30% more than what is habitual. This fact makes that its scientific name *Equisetum arvense* generally appears in the composition of most of products that habitually are sold to reduce weight. This property is due to the action of several components, among which it is necessary to highlight equisetin and potassium, but there are other ones that also take part such as calcium, magnesium, ascorbic acid and caffeic acid ²⁰.

Hepato-protective

Hepatoprotective activity guided fractionation of the MeOH extract of *Equisetum arvense* L. resulted in the isolation of two phenolic petrosins, onitin and onitin-9-O-glucoside, along with four flavonoids, apigenin, luteolin, kaempferol-3-O-glucoside, and quercetin-3-O-glucoside ²¹.

HIV

Screening of some plant extracts for inhibitory effects on HIV-1 and its essential enzymes shows that water extract of aerial parts of *Equisetum arvense* possesses inhibitory effect on HIV-1 induced cytopathy ²².

Vasorelaxant

The Vasorelaxant activities of chicoric acid from *Cichorium intybus* and dicaffeoyl-meso-tartaric acid from *Equisetum arvense* L. in isolated rat aorta strips were studied ²³.

Vulnerary

High silica content is helpful in healing wounds. Externally it may also be applied as a compress to fractures and sprains. The effect of strengthening and regenerating connective tissues has been ascribed to the silicic acid content.

APPLICATIONS OF HORSETAIL PRODUCTS

Horsetail eases the pain of rheumatism and stimulates the healing of chilblains

In some cases *Equisetum* has been found to ease the pain of rheumatism and stimulate the healing of chilblains. Horsetail is used as bathing agent for skin diseases and also shows anti-inflammatory effect. It improves blood circulation^{24, 25}. A preparation containing horsetail is used as anti-cellulite²⁶.

Horsetail in oral hygiene

Dentifrices are available containing methionase inhibitors for preventing bad breath. Mouthwashes containing horsetail extract are also prepared^{27, 28}. A bad breath-controlling candy containing the extract was prepared²⁹.

Horsetail benefit for cardiovascular problems

Horsetail has been established that administration of silicic acid causes leucocytosis (a temporary increase in white blood cells). *Equisetum*'s silica content encourages the absorption and use of calcium by the body and also helps to guard against fatty deposits in the arteries. Its influence on lipid metabolism leads to potential benefit for cardiovascular problems. Horsetail product is also used as lipase inhibitor³⁰.

Horsetail as a diuretic

A beverage comprising vitamin C, a sweetener, organic acid and herbal extracts of *Equisetum arvense* has a diuretic effect³¹.

Horsetail as functional skin remedy

No other herb in the entire plant kingdom is as rich in silicon as horsetail. This trace element really helps to bind protein molecules together in the blood vessels and connective tissues. Silicon is the material of which collagen is made. Collagen is the "body glue" that holds our skin and muscle tissues together. *Equisetum arvense* extract is used as a collagen promoting agent in cosmetics³².

Horsetail (herb): is considered to be the best possible tonic to cure acne and eczema, known to provide excellent healing effect for most skin conditions¹⁷. Horsetail is that kind of rare and unique cosmetic agent which beautifies from the inside out rather than just externally. Mature skin or skin that shows signs of premature aging may fall into this category. Horsetail improves the texture and tone of skin. Horsetail extract is used in cosmetics as an anti-aging agent along with UV adsorbents. Some even ascribe to this herb a certain hidden "youth factor"³³. Horsetail is also used as in cosmetics as a moisturizer and skin conditioning agent³⁴. The extract is used in a cleansing composition suitable for use in body shampoo, hand soap, cosmetic cleanser, and hair shampoo, etc³⁵.

Horsetail as functional hair remedy

Horsetail improves the texture and tone of hair. The hair preparations contain *Equisetum arvense* extracts and silicones or cationic polymers³⁶.

The extracts showed hair growth-stimulating effect in an aged man with alopecia³⁷. Hair conditioners are prepared containing cationic surfactants, silicones, and plant components (*Equisetum arvense* extract). These provide smoothing and conditioning effect to hairs³⁸.

Horsetail in bone disorders

An invention describing a pharmaceutical composition based on *Equisetum arvense* for the treatment of bone diseases, particularly osteoporosis³⁹.

Horsetail in diabetes

A composition for controlling cholesterol comprises cholecalciferol, Dunaliella salina, phytomenadione, d- α -tocopherol, calcium citrate, hydroxyapatite, magnesium oxide, *Equisetum arvense*, amino acid chelate, gluconate, and borax⁴⁰.

Horsetail in varicose veins

Varicose veins can be treated with a preparation containing extracts of *Aesculus hippocastanum*, *Hamamelis virginiana*, and *Equisetum arvense*⁴¹.

Horsetail in nail disorders

Horsetail tea is good for splitting nails and lifeless hair. It is also useful when white spotting occurs on the nails (a symptom said to indicate calcium imbalance in the body. Nail polish is prepared from fresh *Equisetum arvense* stem 50%, maweicao oil 30%; sweet almond oil 15-20%, flower pedal juice 0-5%. The nail polish can protect nail from breaking and provide nutrients to nails⁴².

Silicon from horsetail promotes the growth and stability of the skeletal structure

A few European clinical studies have determined that fractured bones heal much more quickly when horsetail is taken. The incidence of osteoporosis is, likewise, more greatly reduced when some horsetail is added to the diet⁴³. Horsetail extract is also added in a composition used against psoriasis⁴³.

Horsetail in urinary incontinence and overactive bladder

The present invention relates to herbal compositions for the prevention or treatment of disorders of the urogenital system, e.g., urinary incontinence, enuresis (e.g., bed-wetting), benign prostatic hyperplasia, urinary calculi, cystitis, urinary tract infection, and overactive bladder⁴⁴.

Horsetail stops bleeding

The Ancient Greeks used horsetail in the treatment of wounds and the Romans used it as a vegetable, an animal feed and a medicine. Culpeper said it was 'very powerful to stop bleeding, either inward or outward, and eases the swelling, heat, and inflammation of the fundamental, or privy parts, in men and women¹³.

PHYTOCHEMICAL PROFILE

Minerals: Sterile stem are reported to contain silicic acid and silicates (5-8%)⁴⁵, potassium (1.8%), calcium (1.3%), aluminium, sulphur, magnesium and manganese⁴⁶.

Phenolic acids: Sterile stems contain di-E-caffeoyl-meso-tartaric acid⁴⁷, mono-O-caffeoyl-meso-tartrate, methyl esters of protocatechuic and caffeic acids⁴⁸. Barren sprouts contain 5-caffeoylshikimic acid⁴⁹.

Phenolic petrosins: Onitin and oniti-9-O-glucoside²¹.

Flavonoids: Sterile stems reported to contain 0.3-0.9% of total flavonoids. Various flavonoids present are kaempferol 3-O-sophoroside-7-O-glucoside⁴⁵, kaempferol 3-O-(6"-O-malonyl-glucoside)-7-O-glucoside^{50,21}, kaempferol 3-O-sophoroside⁴⁸, quercetin-3-O-glucoside, apigenin, apigenin 5-O-glucoside⁶, luteolin, luteolin 5-O-glucoside⁵¹, genkwanin 5-O-glucoside, isoquercitrin⁵².

Phenolic glycosides: Fertile sprouts contain equisetumoside A, equisetumoside B and equisetumoside C^[53].

Styrylpyrone glucosides: Rhizomes contain 3'-deoxyequisetumpyrone (3, 4-hydroxy-6-(4'-hydroxy-D-styryl)-2-pyrone-3-O- β -D-glucopyranoside)⁵⁴ and 4'-O-methylequisetumpyrone (3, 4-hydroxy-6-(3'-hydroxy-4'-methoxy-E-styryl)-2-pyrone-3-O- β -D-glucopyranoside)⁵⁵. Vegetative stems contain equisetumpyrone⁵⁶.

Triterpenoids: Sterile stems contain isobauerenol, taraxerol, germanicol, ursolic acid, oleanolic acid and betulinic acid⁵⁷.

Alkaloids: Nicotine, palustrine and palustrinine.

Saponins: Sterile stems contain equisetonin¹⁶.

Phytosterols: Sterile stems contain cholesterol, epicholestanol, 24-methylenecholesterol⁵⁷, isofucoesterol (5.9%), campesterol (32.9%) and β -Sitosterol (60%)^{58, 6}.

Branched and long chain dicarboxylic acids: Spores contain C₂₂-C₃₀ compounds⁵⁹.

Other constituents: Plant is reported to contain true proteins ^{60, 61} and Enzymes (mainly Thiaminase) ⁶².

CONTRAINDICATIONS

Chronic ingestion of this herb can decrease the level of thiamin or B₁ due to thiaminase content. Beriberi is the sign of chronic toxicity. This herb should not be consumed long term or by pregnant women. The diuretic effect can cause loss of potassium ³.

TOXICITY

Horsetail can produce toxic effects on its prolonged use. Silicates produce digestive problems, especially when used for long. Alkaloids although do not appear in strong concentrations, a prolonged use, can take place by accumulating them in the organism which may facilitate premature childbirth, nervous disorders, headaches, loss of appetite, swallowing problems, etc. These intoxications force to a treatment that restores the thiamine deficiency, although in the case of the animals, they are no longer recoverable in many occasions ⁶³.

CONCLUSION

The traditional uses and therapeutic activity of *Equisetum arvense* has been established through modern testing and evaluation (pre-clinical and clinical trials) in different disease conditions. These investigations place this indigenous drug as a novel candidate for bioprospection and drug development for the treatment of such diseases as anaemia, inflammation, cancer, convulsions, diabetes. The medicinal applications of this plant and countless possibilities for investigation still remain in relatively newer areas of its function. Hence phytochemical and minerals of this plant will enable to exploit its therapeutic use.

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