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Constituents and pharmacology of *Geum urbanum*- A review

Ali Esmail Al-Snafi
Department of Pharmacology, College of Medicine, University of Thi qar, Iraq.
Corresponding Author: Ali Esmail Al-Snafi

Abstract: *Geum urbanum contained phenolic compounds (gallic, caffeic, chlorogenic acids and eugenol), vicianose sugar, carotenoids, flavonoids, tannins (10.5%), volatile oil and sesquiterpene lactone (cnicin). It possessed many pharmacological activities included antiinflammatory, antimicrobial, antioxidant, neuroprotective, Parkinsonian, hypotesive and many other effects. The current review was designed to highlight the chemical constituents and pharmacological effects of Geum urbanum.*

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I. INTRODUCTION

Plants generally produce many secondary metabolites which are constitute an important source of many pharmaceutical drugs. Recent reviews revealed that the medicinal plants possessed central nervous[1-4], cardiovascular[4-7], antioxidant[8-10], reproductive [11-15], gastro-intestinal[16-20], respiratory[21-22], antidiabetic[23-25] and many other pharmacological effects. *Geum urbanum* contained phenolic compounds (gallic, caffeic, chlorogenic acids and eugenol), vicianose sugar, carotenoids, flavonoids, tannins (10.5%), volatile oil and sesquiterpene lactone (cnicin). It possessed many pharmacological activities included antiinflammatory, antimicrobial, antioxidant, neuroprotective, Parkinsonian, hypotesive and many other effects. The current review will highlight the chemical constituents and pharmacological effects of *Geum urbanum.*

Synonyms:

Caryophyllata officinalis Moench, Caryophyllata urbana (L.) Scop., Caryophyllata vulgaris Lam., Geum caryophyllata Gilib., Geum hederifolium C. C. Gmel., Geum hirtum Wahlb., Geum hyrcanum C. A. Mey., Geum ibericum Besser ex Boiss., Geum klettianum Peterm., Geum latilobum Sommier & Levier, Geum rivale subsp. urbanum (L.), Geum robustum Schur, Geum roylei Wall. ex F. Bolle, Geum rubifolium Lej., Geum sordidum Salisb., Geum urbanum var. mauritanicum Pomel, Geum urbanum var. platyolobum Rouy & E. G. Camus, Geum urbanum var. stenolobum Rouy & E. G. Camus, Geum vidalii Sennen, Streptilon odoratum Raf[26].

Taxonomic classification:

Kingdom: Plantae**, Subkingdom**: Viridiplantae , **Infrakingdom**: Streptophyta, **Superdivision**: Embryophyta, **Division:** Magnoliophyta, **Class:** Magnoliopsida**, Order:** Rosales, **Family:** Rosaceae, **Genus:** Geum**, Species:** *Geum urbanum*[27].

Common names:

English: avens, Bennet's-root, clove root, herb-bennet, wood avens; **German:** Nelkenwurz; **Italina:** erba benedetta, ambretta; **Portuguese**: erva-benta, erva-de-São-Benedito; **Spanish:** ganiofilia; **Swedish**: nejlikrot[28-29].

Distribution:

The plant was distributed in **Africa**: (Algeria, Morocco, Tunisia); **Asia** (Armenia, Azerbaijan, Georgia, Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Iran, Iraq, Turkey); Europe: (Estonia, Latvia, Lithuania, Moldova, Ukraine, Austria, Belgium, Czech Republic, Germany, Hungary, Netherlands, Poland, Slovakia, Switzerland, Denmark, Finland, Ireland, Norway, Sweden, United Kingdom, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Italy, Romania; Slovenia, France, Portugal, Spain) and Australasia: (Australia, New Zealand) . The plant was also cultivated in Europe and North America[28].

Description:

The plant has thin, nearly upright, wiry stems, slightly branched, from 1 to 2 feet in height, of a reddish brown on one side. Its leaves vary considerably in form, according to their position. The radical leaves are borne on long, channelled foot-stalks, and are interruptedly pinnate, the large terminal leaflet being wedge-shaped and the intermediate pairs of leaflets being very small. The upper leaves on the stem are made up of three long, narrow leaflets. The stem-leaves are placed alternately and have at their base two stipules. All the leaves are of a deep green colour, more or less covered with spreading hairs, their margins toothed. The rhizomes are 1 to 2 inches long terminating abruptly, hard and rough with many light brown fibrous roots. The flowers, rather small for the size of the plant, are on solitary, terminal stalks. The corolla is composed of five roundish, spreading, yellow petals, the calyx cleft into ten segments, five large and five small[30].

Traditional uses:

It was used as a sedative , hemostatic, astringent and anti-inflammatory[31]. Internal folk medicine applications include use for digestive problems such as loss of appetite and diarrhea. The root has been used externally as a gargle for gum and mucous membrane inflammations and as a bath additive or poultice for frost bite, hemorrhoids and skin diseases. Homeopathic applications included use for inflammations of the bladder and urinary tract[32-33].

Part used:

The medicinal parts of the plant are the dried flowering herb, the dried or fresh underground parts and the roots[30,32].

Chemical constituents:

The preliminary phytochemical analysis showed that the plant contained phenolic compounds (gallic, caffeic, chlorogenic acids and eugenol), vicianose sugar, carotenoids, flavonoids, tannins (10.5%), volatile oil and sesquiterpene lactone (cnicin)[29,31,34-35].

Free vicianose (a crystalline disaccharide sugar $C_{11}H_{20}O_{10}$) were isolated from the rhizodermis and primary bark of the roots of Geum urbanum during the whole year. The highest content of vicianose was determined in the flowering stage. Vicianose was isolated as a white powder, changed to syrup consistency within few weeks[36].

Geum urbanum aqueous extract contained total phenolic acid 768.2±25.9 mg GAE/l, total flavonoid 14.7±0.9 mg RE/l and Proantocyanidins 37.5±1.4 mg CE/L, while ethanol extract ontained total phenolic acid 1261.5±31.3 mg GAE/l, total flavonoid 49.9±2.2 mg RE/l and Proantocyanidins 60.1±2.1mg CE/L[37].

Six ellagitannins were isolated from roots of Geum urbanum included gemin A, pedunculagin, stachyurin, stenophyllanin A, casuarinin and gemin G[38].

The total ellagic acid in the aerial parts extract of *G. urbanum* was 46.71± 0.51 and in the underground parts extract was 32.19±0.50 mg/g, while the total gallic acid in the aerial parts extract was 8.35± 0.29 and in the underground parts extract was 5.25±0.11 mg/g[39].

However, in studying the phenolic compounds of Geum urbanum, two flavan-3-ols and three polyphenolic acids were found in leaves, while five flavan-3-ols and two polyphenolic acids in underground organs. The populations differed especially in respect of the content of catechin and epicatechin in underground organs. The contents of polyphenols in Geum urbanum underground organs of central area of Poland were: ellagic acid 88.66, gallic acid 122.30, (+) catechin 600.46, (-)epi catechin 432.32, (-)epigallo catechin 135.13, epicatechin gallate 136.82, (-)epigallo catechin gallate 157.68 mg/100g. While in the samples taken from eastern area of Poland were: ellagic acid 73.24, gallic acid 97.10, (+) catechin 402.44, (-)epi catechin 263.13, (-)epigallo catechin 107.08, epicatechin gallate 116.12, (-)epigallo catechin gallate 115.65 mg/100g. The contents of polyphenols in Geum urbanum herb organs of central area of Poland were: ellagic 66.67, chlorogenic acid 24.57, gallic acid 50.88, (+) catechin 74.56, epicatechin gallate 3.07 mg/100g. While in the samples taken from eastern area of Poland were: ellagic 72.05, chlorogenic acid 40.29, gallic acid 46.40, (+) catechin 58.78, epicatechin gallate 3.88 mg/100g[40].

The essential oils of the underground parts of *G. urbanum* contained 32 compounds comprising 99.6% of the oils. The composition of the oil from *G. urbanum* root was dominated by eugenol (69.2%), followed by *cis*-myrtanal (15.3%), and related compounds with a pinane skeleton: *trans*-myrtanol (3.2%), myrtenal (3.0%), *trans*- myrtanal (2.9%) and myrtenol (2.1%). These six compounds accounted for 95.7% of the oil. Some other monoterpenes were detected, but only in small amounts (0.9%), phellandral (0.5%) being the most abundant one. The oil, besides these, also contained 1.6% of the bicyclic ketone – nopinone[33].

Vollman et al., isolated 60 compounds from the root essential oil of G. urbanum, they identified only 29 compounds, representing 99% of the oil. Apart from the main component eugenol (67%), most of the isolated compounds were oxygenated monoterpenes with a pinane skeleton, e.g. myrtanal and myrtanol. All these compounds were also found in a pentane/ether extract of the fresh roots). Altogether the oil consisted of 32% monoterpenoids, 0.1% sesquiterpenoids, 67% phenylpropanoids and 0.1% miscellaneous compounds[41].

Pharmacological effects:

Antiinflammatory effect:

In a screening of Swedish traditional remedies Calluna vulgaris and Geum urbanum were reported to inhibit prostaglandin biosynthesis and platelet activating factor (PAF)-induced exocytosis in vitro[42].

The dried Geum urbanum herb was pulverized and extracted with many solvents. Extracts were tested (10 mg/Ml) on PPAR-α and PPAR-γ activation as well as on NF-κB inhibition , dichloromethane extract possessed moderate, moderate and strong effects, while dichloromethane extract without chlorophyll possessed strong, moderate and moderate effects respectively[43].

Antimicrobial effect:

The effects of extracts on bacterial growth were measured *in vitro* by agar disc diffusion method against many types of plant and human pathogenic bacteria. The results revealed that *Geum urbanum* leaves methanolic extracts showed the maximum activity against all bacteria, including *Pseudomonas aeruginosa*, followed by *Pseudomonas viridiflava*, *Bacillus subtilis*, *Rathayibacter toxicus*, *Xanthomonas campestris*, *Acidovorax avenae*, *Staphylococcus aureus*, *Pseudomonas syringae. syringae*, *Erwinia amylovora* and *Escherichia coli*, respectively. The maximum antibacterial activity of *Geum urbanum* root extract was observed against: *Pseudomonas aeruginosa*, followed by *Escherichia coli*, *Pseudomonas viridiflava*, *Rathayibacter toxicus*, *Pseudomonas syringae. syringae*, *Bacillus subtilis*, *Acidovorax avenae*, *Xanthomonas campestris*, *Staphylococcus aureus* and *Erwinia amylovora*[44]

Antioxidant effect:

The antioxidant potential of different parts of *G. urbanum* was studied using various *in vitro* methods (DPPH, FRAP and linoleic acid peroxidation test). The results revealed that DPPH (EC_{50} µg/ml), FRAP (mM/g), LA oxidation inhibition (IC_{50} µg/ml) and total phenolic content (% GAE) of aerial parts extract of *G. urbanum* were 26.57 ±1.24, 1.89 ±0.07, 366.60 ±14.47, 7.61 ±0.36, and of underground parts extract of *G. urbanum* 26.92 ±1.31, 1.94 ±0.06, 544.74 ±26.43, 7.89 ±0.27 respectively[45].

G. urbanum extracts exerted remarkable scavenging effect against 2, 2-diphenyl-1- picrylhydrazyl (IC_{50}, 7.8 ± 0.5 µg/ml aqueous extract, and IC_{50}, 1.3 ± 0.1 µg/ml ethanol extract, respectively)[37].

Neuroprotective effect:

The extracts from three Romanian medicinal plants (E. planum, G. urbanum, and C. benedictus) were investigated for their possible neuroprotective potential. The in vitro neuroprotective activity of the extracts were investigated via inhibition of acetylcholinesterase and tyrosinase. AChE inhibitory activities of Geum urbanum aqueous extract were 27.03±1.5, 36.48±1.7 and 79.11±3.9 % at concentration of 0.75 mg/ml, 1.5 mg/ml and 3 mg/ml respectiviley and IC_{50} mg/ml was 2.293±0.14, while AChE inhibitory activities of Geum urbanum ethanol extract were 54.74±2.7, 73.53±5.1 and 86.77±5.1 respectively and IC_{50} mg/ml was 0.513±0.03. All the concentration of aqueous and ethanol extracts (0.75 mg/ml, 1.5 mg/ml and 3 mg/ml) inhibited tyrosinase more than 50%, ethanolic extract was more potent tyrosinase inhibitor than aqueous[37].

Effect on Parkinson's disease:

The presence of Lewy bodies and Lewy neurites is a major pathological hallmark of Parkinson's disease and is hypothesized to be linked to disease development. . Lewy bodies and Lewy neurites primarily consist of fibrillated α-Synuclein. The inhibitory activity of an ethanolic extract of Geum urbanum against α-Synuclein fibrillation was studied. The anti-fibrillation and anti-aggregation activities of the plant extract were monitored by thioflavin T fibrillation assays and size exclusion chromatography, while structural changes were followed by circular dichroism, Fourier transform infrared spectroscopy, intrinsic fluorescence, small angle X-ray scattering and electron microscopy. Geum urbanum inhibited α-Synuclein fibrillation in a concentration dependent way, and to partly disintegrate preformed α-Synuclein fibrils. Based on the structural changes of α-Synuclein in the presence of extract, It appeared that Geum urbanum delayed α-Synuclein fibrillation either

by reducing the fibrillation ability of one or more of the aggregation prone intermediates or by directing α-Synuclein aggregation towards a non-fibrillar state[46].

Hypotensive effect:

A 20% aqueous decoction of avens, administered by intravenous injection, has been reported to produce a reduction in blood pressure in cats[47].

Other effects:

The main compounds detected in the extract of Geum urbanum root belong to the group of ellagitannin (gemin A) significantly affected the functions of stimulated neutrophils by reducing the surface expression of CD11b, and inhibiting the release of reactive oxygen species, and proteases (elastase, MMP-9), chemokines and cytokines (interleukins IL-8, IL-1β). Gemin A stimulated the release of TNF-α, which may be one of the stimulators of apoptosis of neutrophil cells. The primary aqueous extract, the ethyl acetate and the butanolic fractions, all containing the highest level of gemin A, have exerted similar but weaker activity[48].

A-Hepatica is an herbal combination (contained ten herbs included Geum urbanum (Clove root- 6.5 ml) was used for detoxification of the liver and gallbladder. A-Hepatica was said to be regulates secretion and absorption in the digestive system, has anti-inflammatory and antispasmolytic function in the portal vein, stimulates bile flow and increases detoxification of the liver[49].

Side effects and contraindications:

Avens was listed by the Council of Europe as a natural source of food flavouring (category N2). No Health risks or side effects following the proper administration

of designated therapeutic dosages were not recorded. Avens affected the menstrual cycle. Its uses during pregnancy should be avoided[32,50].

Dose:

Dosages for oral administration (adults) : Dried herb 1–4 g as an infusion three times daily. Liquid extract 1-4ml (1 : 1 in 25% alcohol) three times daily. To prepare an internal infusion, boil 1–4 g coarsely powdered drug in water for 10 minutes and filter. Prepare an external infusion by adding 1 teaspoon coarsely powdered drug to cold water, bringing it briefly to the boil, leaving it to steep for 10 minutes and then straining[32,50].

II. CONCLUSION

The current review discussed the chemical constituents and pharmacological effects of *Geum urbanum* to be utilize in medical practice as a result of effectiveness and safety.

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