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Phytoconstituents and Pharmacological Profile of *Echinacea purpurea*

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Abstract

Echinacea purpurea (Asteraceae) is a medicinal herb that has broad spectra of pharmacological properties. It is a perennial herb with immune-stimulant and anti-inflammatory properties. Due to its vast pharmacological properties, this plant has attracted the attention of scientists to evaluate other beneficial biological effects. The plant has shown antidepressant, anxiolytic, anti-mutagenic, cytotoxic, antifungal and antibacterial properties. The objective of this review is to highlight the importance of *Echinacea purpurea*. Different databases were used to search literature in the English language. Clinical studies are still not found due to its adverse effects. But some plant studies have shown the best biological responses, with no serious side effects, while some studies have reported severe adverse effects on the skin such as rashes, urticaria and itching, abdominal cramps, pain, nausea and labored breathing. Cichoric acid and alkamides analysis have been developed by high-performance liquid chromatography (HPLC) by using different detectors, for example, coulometric detectors, ionization mass spray detectors and Uv-vis detectors. Instead of controversial results of different studies on this plant, some activities show the best results, But some questions are still there. *Echinacea purpurea* plant has a lot of work that needs to be done in the future by considering the mechanism of action.

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Introduction

Echinacea purpurea is one of the medicinal herbs of the Asteraceae family, with the habitat of eastern North America. It was the first time used by native Americans to enhance body immunity (Mckeown, 1999). Traditionally, it was being used to cure toothache, arthritic pain, worst skin conditions, snake venom bite and cancers (Grimm and Muller, 1999). The plant also has shown the best result in chemotherapy of many diseases. The same species of this family have been used to treat respiratory tract infections (cold, flu) and urinary tract infections (vaginal yeast infection) (Patel *et al.,* 2008).

Scientists isolated its major compounds and elucidated their structures. Alkamides, caffeic acid derivatives, and polysaccharides were major plant constituents. Many studies were conducted to check the pharmacological activity of the extract. Immunomodulatory activity is due to alkamides (Goel *et al.,* 2002; Gertsch *et al.,* 2004). Anti-inflammatory activity was estimated due to the presence of polysaccharides in extracts (Laasonen *et al.,* 2002).

Some other species of *Echinacea* genus, such as *E. angustifolia*, *E. pallida*, and *E. purpurea* are reviewed in past papers according to chemical, pharmacological, and clinical properties (Barnes *et al.,* 2005). According to some reviewed papers on the medicinal properties of the plant, further research studies can be conducted on it (Barrett, 2003).

This paper is reviewed different extraction techniques, and phytochemistry, biological and pharmacological activities of *E. purpurea species. Paper is also reviewed about* psychoactive and mosquitocidal effects of extracts.

Properties

Extracts of *E.Purpurea* possess many pharmacological properties in which most important is its immune-modulatory property. *Echinacea Purpurea* plant is being used since ancient times to treat inflammation and swelling of the skin by reducing the level of cytokines in the epithelial membrane. It has many other properties such as anti-venome (in snake bite), mosquitocidal property (aegypti larvae), antifungal (against *Saccharomyces cerevisiae* and *Candida albicans*) and antibacterial (Clifford *et al.,* 2002; Stojicevic *et al.,* 2009; Saiednia *et al.,* 2011).

It also has the property of enhancing immunity in colds and flu. For this purpose, a standardized solution of *Echinacea Purpurea* plant is being used commonly (Sharma *et al.,* 2009).

This formulation also possesses anticancer, anxiolytic and anti-viral properties (Chicca *et al.,* 2007; Sharma *et al.,* 2010).Experimental studies of secondary metabolites such as polysaccharides, glycoproteins, caffiec acid and alkamides show immune-stimulatory activity (Barnes *et al.,* 2005).

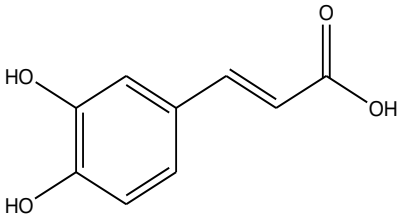
The plant *Echinacea purpurea* possesses enormous properties (Bergmann, 1995).

Constituents of Echinacea Purpurea

Plant extracts contain polysaccharides, chicoric and caffeic acid, alkyl amides and flavonoids.

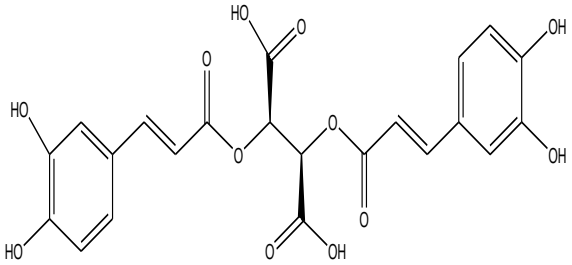
Caffeic acid

Caffeic acid is the main constituent of extracts which is an important metabolic product in plants. Chemically it is 3,4 dihydroxycinnamic acid which is phenolic acid. Derivatives of phenolic acid are monomers and oligomers of caffeic acid, and these are water-soluble (Barrett, 2003).



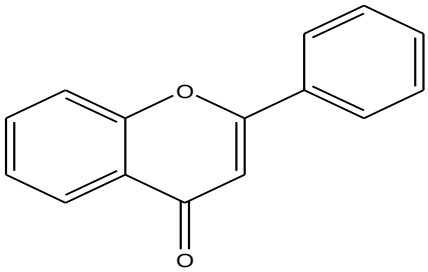
Chichoric acid

it is one of the main components of extracts, identified in 1958. It contains anti-viral (anti-HIV), anticancer and anti-obesity properties (Hao *et al.,* 2015).



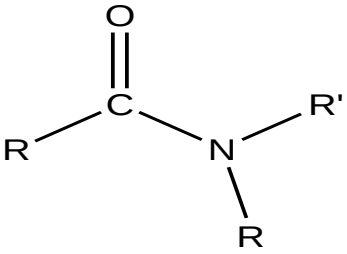
Falvonoids

Nicotiflorin and rutin are two major flavonoids found in *Echinacea purpurea* extracts.



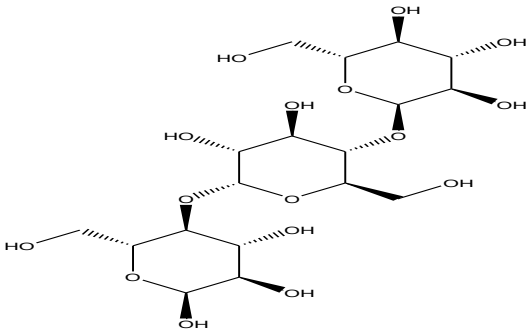
Alkamides or alkyl amides

Lipophilic component alkamides, show phagocytosis property when inserted orally in rats (Jungmin *et al.,* 2013).



Polysaccharides

Results of studies on mice showed its influence on nonspecific immunity. EP also enhances cytotoxicity against tumor cells (Kreft *et al.,* 2014).



Pharmacological activities

Echinacea purpurea is used anti-viral properties

Some studies show an aqueous fraction of flowers, leaves and stems of echinacea purpurea contains anti-viral properties against herpes simplex virus and influenza virus because ethanol and ethyl acetate present in leaves and stems are anti-viral (Steinmüller *et al.,* 1993).

Anti-oxidant activity

It also contains anti-oxidant properties. These oxidants are chichoric acid, rosmarinic acid and flavonoids.

These anti-oxidants are extracted from the fruits, and flowers of the plant.

Cytotoxic activity

The chichoric acid, which is extracted from flowers of *Echinacea purpurea* is used to inhibit the human colon cancer lines n-hexane, which is obtained from the roots of *Echinacea purpurea,* also shows anticancer activity (Shaffique *et al.,* 2018).

Anti-inflammatory activity

Some studies show EP is an anti-inflammatory agent which can reduce the symptoms of respiratory infections against many bacteria like *Streptococcus pyrogens*, *Hemophilus influenza*, *Legionella pneumophila*, *Staphylococcus aureus* (Manayi *et al.,* 2015).

Ailment for upper respiratory tract

Some results of many days study on the subject shows that Echinacea and tea can reduce the symptoms of the upper respiratory tract includes the portion of the larynx below the vocal folds, trachea, bronchi and bronchioles (Canlas *et al.,* 2010).

Immune-suppressant activity

It is the most popular herb used as immune-stimulants in North America and Europe. Some studies show it has anti-immune-suppressant properties when it is used on mice.

These studies showed that EP could increase immune functions (Shaffique *et al.,* 2018).

Immuno-stimulant capacity

The Native Americans consume the *Echinacea purpurea* L. as a medicinal plant to treat: infections related to the respiratory tract, wound curing, and boost the immune system. The metabolite contents were enlisted, which are polysaccharides (162.2±8.4), total phenolic content (22.3 ±1.0 mg Gallic acid/g of TP), total flavonoid content (86.0 ± 4.6 mg quercetin equivalent/g of TF) in the extract of *Echinacea purpurea* plant, which was made in ethanol 55% to distilled water (1:10). The outcomes of in vitro study were concentration-dependent for NO production, TNF- α and cell viability by the use of chicken peripheral blood mononuclear cells (PBMCs), and RAW 264.7 macrophages were 89% and 81% individually (Lee *et al.,* 2010).

Effect of Echinacea purpurea on antibody and immune cell response

To check the antibody and immune cell response against the snake venom by the administration of root of the aqueous plant extract. The results were remarkable; there is an increase in antibody production in the body against the venom. The in-vitro study also showed there was an uprise in lympho-proliferation when the root extract and lectin were used combined (Chaves *et al.,* 2007).

Effect of Echinacea purpurea as anti-oxidant on markers of aging

The outbreak against the oxidation was the consumption of active constituents of natural sources. The effectiveness of water and ethanol extract of the root of the plant on mice was tested against different parameters such as superoxide dismutase (SOD) and glutathione-s- transferase (GST), liver functions, total cholesterol, lipoprotein, triglycerides levels, blood hemoglobin and hematocrit counts. The plant extracts have the potential to keep the level within the range (Soudi *et al.,* 2010).

Efficiency of Echinacea purpurea on total anti-oxidant activity

The total anti-oxidant activity, which is composed of prevention of oxidation and scavenging of free radicals, was conducted in broiler chicks. The dried aerial parts of Echinacea purpurea (EP) were given in powder form against an antibiotic (flavophospholipol). The response of the activity was absent in the aerial part but, at the dose of 10 g/kg the activity was impressive (Wang *et al.,* 2008).

A first clinical trial was led to figure out the immune response of *E. purpurea* on volunteer females. These patients were treated with different residues of plant: purpurea/E. angustifolia or *E. purpurea/E. angustifolia* plus larch arabino-galactan, after the period of four weeks the properdin rises which was an immune-stimulant.

The active compound extracted from the butanol fraction of stem and leaves was tested for its proteomic profile on the mouse in dendritic cells primary cultures, maturation of phenotype of dendritic cells remains unaffected and the uprise of expression of anti-oxidant and cytoskeletal proteins (Ghalamkari *et al.,* 2011).

Cytochrome p450 activity

The cytochrome P450 (CYP) was inhibited by the tincture of Echinacea in *in-vitro* testing. While *in vivo* testing, the roots of the plant were checked with the CYP substrate drugs: caffeine (CYP1A2), tolbutamide (CYP2C9), dextromethorphan (CYP2D6), and by oral and intravenous route midazolam (hepatic and intestinal CYP3A). The various effects were observed with Echinacea that are: it diminishes the oral clearance of caffeine and but no consequence on the tolbutamide and dextromethorphan.

Anti-viral activity

The aqueous extract of aerial parts of the plant: stems, leaves, and flowers have potent anti-viral activity against herpes simplex virus and influenza virus. These can be used in the cure of UTI and also possess immune-enhancing properties.

The ethanol and ethyl acetate soluble fraction from leave and stem detected thiophenes, alkaloids, complex quinones, polysaccharides, and cichoric acid

might be the potential component for their action against viruses, which was lacking in the flower extract (Vimalanathan *et al.,* 2005).

Toxicology and adverse effects

The studies on different parts of the plant of *E. purpurea*: root extract, aerial parts, and pressed juice reported few unwanted side effects or toxicity (Mengs *et al.,* 1991).

Anti-leishmanial effect

The study reported that plants improve the immunity against leishmaniasis: the ethanol extract of the root of the plant was leishmanicidal at the concentration of 50 mg/ml (Lee *et al.,* 2010).

Other pharmaceutical uses

Acid indigestion, chronic fatigue syndrome, diphtheria, dizziness, gum disease, malaria, migraine, syphilis, tonsillitis, urinary tract infections and vaginal yeast infections (Barrett *et al.*, 2003).

Conclusion

Medicinal plants have remained the source of attraction since ancient, to treat people in all disease cases. Even they don't know the mechanism of action of the plant, but they treat people with these extracts. Recent researches are based on a major mechanism of action which leads to its pharmacological use to prepare a formulation. Formulations or drugs which have a natural origin possess great pharmacological action potential with fewer side effects. It will be pharmaco-economic as compared to synthetically originated drugs. The *Echinacea purpurea* contain enormous phytochemicals with many pharmacological properties. So, it can be used in the pharmaceutical industry to produce a new variety of formulations to treat different diseases. This review of the plant is advantageous in future researches and may be helpful in pharmacy to produce drugs.

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