



**International Journal of Biology, Pharmacy  
and Allied Sciences (IJBPAS)**

*'A Bridge Between Laboratory and Reader'*

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**ANTIVIRAL ACTIVITY OF ECHINACEA (*ECHINACEA PURPUREA*)**

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**ABSTRACT**

Antiviral drugs effect on specific and limited virus family. Also viral replication inhibitor drugs have toxic effects on host cells. In addition, viruses are resisting to antiviral drugs. As a result, it is necessary to new drugs with fewer side effects or no side effects. Medical plants such as Echinacea (*Echinacea purpurea*) have been used for viral infections treatment including cold and rabies, traditionally. In the article, we try to introduce Echinacea antiviral activity and its potential of viral disease treatment like cold, AIDS, herpes, inflammation of the cornea and conjunctiva (keratoconjunctivitis) and encephalitis.

**Keywords:** *Echinacea purpurea*, Antiviral Activity, HIV, cold, HSV

**INTRODUCTION**

Viruses are intracellular mandatory parasites which use cell biosynthetic machinery and enzymes for replication. Antivirus medicines are employed against encoded enzymes by virus or viral structures which are necessary for replication. Most of these compounds are classical biochemical inhibitors of virus

enzymes. But prevention of virus replication is very difficult without toxic effects on host cell. Against antibacterial drugs, usually antiviral drugs are limited to specific family of virus. Similar antibacterial drugs, resistance to antiviral drugs are increasing due to increasing mutation rate in virus and long-term

treatment especially in Patients with weakened immune systems (e.g. AIDS Patients). Production of antiviral medicine is developed against viruses which are significantly fatal agents (Murray *et al.*, 2015). According to increasing resistance to antiviral medicine and medication side effects, it is necessary to evaluation, design and product of novel antiviral medicines with more appropriate characteristics and lack/loss side effects. Therefore, antiviral activity of Echinacea is introduced in this article.

### **Echinacea (*Echinacea purpurea*)**

Echinacea (*Echinacea purpurea*) is the composite family *Asteraceae*. Common characteristic of the family is purple cone flower. Echinacea is perennial and

herbaceous plant (Binns *et al.*, 2002). It is up to 120 cm tall and native to eastern North America. Also currently, it grows in many regions of east, southeast and west of United State naturally. Dependent on climate, Echinacea blooms throughout spring to late summer (McKeown, 1999). Individual flowers of Echinacea are hermaphrodite. In another hand, each flower possesses male and female sexual organs. Butterflies and bees pollinate its flowers. Habitats of Echinacea include dry woods, prairies and barrens. Echinacea is cultivated as an Ornamental plant. Several varieties of Echinacea have been improved for flower quality (Ault, 2007). Scientific classification of Echinacea (*Echinacea purpurea*) is shown below (table 1).

**Table 1. Scientific classification of Echinacea (*Echinacea purpurea*) (McKeown, 1999)**

Kingdom	Division	Class	Order	Family	Tribe	Genus	Specie
Plantae	Angiosperms	Eudicots	Asterales	Asteraceae	Heliantheae	Echinacea	<b>E. purpurea</b>

### **Secondary Metabolites**

Echinacea extract analysis is performed by some methods like HPLC (Sharma *et al.*, 2009). It contains polysaccharides, flavonoids, Alkylamids, polyacetylenes, glycosides (Kumar *et al.*, 2011), glycoproteins (Awang, 1999), polyphenolics (Birt *et al.*, 2008) and essential oils. Studies revealed that secondary metabolites of Echinacea include Chicoric acid (Kumar *et al.*, 2011), Cichoric

acid, Echinacin (Birt *et al.*, 2008), Cynarin (Fusco *et al.*, 2010) Echinacoside, PID8/9, Chlorogenic acid (Sharma *et al.*, 2009) and Caffeic acid derivatives (Vilmalanatham *et al.*, 2005). There is not no endotoxin in extract of Echinacea (<0.1 unit per ml) (Sharma *et al.*, 2009). Some secondary metabolites of Echinacea and their concentrations are available in table 2.

**Table 2. secondary metabolites of Echinacea and their concentrations (Sharma *et al.*, 2009; Pleschka *et al.*, 2009)**

Compound	Concentration ( $\mu\text{g/mL}$ )
Caffeic acid	13 $\pm$ 0
Caftaric acid	264.4 $\pm$ 13.0

Chlorogenic acid	40.2 ± 2.0
Cichoric acid	313.8 ± 0
Cynarin	2.0 ± 0
Echinacoside	6.9 ± 0.4
PID 8/9	36.3 ± 1.8

### Medical uses

Echinacea (*Echinacea purpurea*) is used pharmaceutically (Pullaiah, 2006). Most Native Americans have been using Echinacea medically for treatment of many diseases including cold, toothache, snakebite, headache and infected wounds (Kumar *et al.*, 2011). Also roots of Echinacea have been used to cure of blood poisoning, snake venom, skin diseases, syphilis and rabies (Pullaiah, 2006). In addition, influenza and candidacies were treated by Echinacea (Sharma *et al.*, 2009). Clinical trials have confirmed the medicinal properties of Echinacea. Studies indicate that Echinacea control bacterial infections (Sharma *et al.*, 2008). Also Echinacea can treat chronic respiratory tract infection and lower urinary tract which have bacterial and viral origin (Pullaiah, 2006). Researches have been reported immunomodulatory activity of Echinacea (Turner *et al.*, 2000). Echinacea possess Effective antioxidant compounds which simulate immune system and cytokine production. It has antiviral and antibacterial activity by immune system simulation (Mishima *et al.*, 2004). Polysaccharides of Echinacea effect on immune system medically (Kumar *et al.*, 2011). Arabinogalactan is one of the

polysaccharides which purified from cell culture of Echinacea. It activates cytotoxic activity of phagocytes against cancerous cell and microorganism (Pullaiah, 2006). Also arabinogalactan induces tumor necrosis factor (TNF) release which increases the level of macrophage interlekin-1 and interferon beta-2. Heteroxylan is other polysaccharides of Echinacea. It induces phagocytic activity. Alkylamide and Chicoric acid glycosides also stimulate phagocytosis. Isobutylamide is one of the alkylamides which gives pungent smell and distinct taste for Echinacea (Kumar *et al.*, 2011). Echinacea has antibacterial activity and bactericide effects (Sharma *et al.*, 2009). It's occurred by the polysaccharides. Echinacea can kill wide range of bacteria including *Staphylococcus aureus* (Pullaiah, 2006), *Streptococcus pyogenes* and *Haemophilus influenzae*. In addition *Legionella pneumophila* is very sensitive to Echinacea (Sharma *et al.*, 2009). Also alkylamides of Echinacea have antifungal activity (Vilmalanatham *et al.*, 2005). Various pharmacological studies of Echinacea determine its parenteral formulation. But formulation of oral use isn't defined (Mishima *et al.*, 2004).

### Antiviral activity

Echinacea has antibacterial and antiviral activity. Increasing rate of viral antigens was observed in cultured cells which were infected by virus and exposed extract of Echinacea. Hydrophilic and lipophilic extract of Echinacea contain more inhibitors components of viral infection. Echinacea extract prevents virus replication in model cells (Kumar *et al.*, 2011). Alcoholic extract which is prepared from aerial parts of Echinacea and the roots, is a veridical agent for several coated viruses. 1:10 concentration of Echinacea extract is able to kill least  $10^5$  infectious viruses by direct contact. Intracellular viruses are resistance to Echinacea inhibitory effects. But extracellular virus particles are vulnerable and sensitive to Echinacea extract. Echinacea inhibitory effects are activated in the initial contact with the virus, inception of virus infection and against transmission of the virus from infected cells. Continuous application of Echinacea cause less resistant viral strains (Hudson, 2012).

Influenza virus is one of one of the agents of acute respiratory viral infection. Influenza virus type A is more important between the animal and human strains, because it can rearrange its genome and cause epidemic. Echinacea contains substances which act against influenza

virus (Hudson, 2012). Aqueous derivatives of Echinacea have potent activity against influenza virus. Anti-influenza activity of equal extract of Echinacea has been proven. Anti-influenza activity of Echinacea alcoholic extract is more than equal extract (Vilmalanatham *et al.*, 2005). Alcoholic extract of Echinacea has strong veridical effect. It is anticipated that substances of Echinacea alcoholic extract inhibit receptor binding activity and cell entry (Hudson, 2012). Generally, Echinacea deactivates influenza virus (Vilmalanatham *et al.*, 2005).

Herpes simplex virus 1 and 2 (HSV-1 and HSV-2) cause Infections which are categorized based on the part of the body infected, including herpes, inflammation of the cornea and conjunctiva (keratoconjunctivitis) and encephalitis (Steiner *et al.*, 2013). Aqueous derivatives of Echinacea have potent activity against herpes simplex virus. Anti- herpes virus activity of equal extract of Echinacea has been proven. Anti- herpes virus activity of Echinacea alcoholic extract is more than equal extract (Vilmalanatham *et al.*, 2005). Alcoholic extract of Echinacea has strong veridical effect against herpes simplex virus. Echinacea contains substances which have antiviral activity against herpes simplex virus (Hudson, 2012). Benzalkonium chloride and phytochemical

compounds which are extracted from Echinacea, kill herpes simplex virus in human model cells (Kumar et al., 2011). Echinacea deactivates herpes simplex virus in general (Vilmalanatham et al., 2005).

The virus of human immunodeficiency causes HIV infection AIDS. AIDS is a human disease which progressively debilitates the immune system against threatening opportunistic infections and cancers (Douek *et al.*, 2009). Echinacea has strong inhibitory activity against HIV. Increasing concentration of Echinacea extract increases antiviral activity against HIV. It is caused by caffeic acid diversities. Also, Cichoric acid inhibits HIV replication (Birt *et al.*, 2008).

Rhinoviruses are the most common viral infectious agents in common cold (Ellen et al., 2014). Rhinovirus is sensitive to high concentration of Echinacea which have been recommended for oral consumption (Hudson, 2012).

Severe acute respiratory syndrome (SARS) is a viral respiratory disease of zoonotic origin caused by the SARS Coronavirus (SARS-CoV). Between November 2002 and July 2003, an outbreak of SARS in southern China caused an eventual 8,096 cases and 774 deaths reported in multiple countries with the majority of cases in Hong Kong (Smith, 2006). Echinacea prevents SARS returning

due to veridical properties effectively (Hudson, 2012).

Echinacea have antiviral activity against Coronavirus. Calicivirus is sensitive to Echinacea in recommended high concentration for oral consumption (Hudson, 2012).

## CONCLUSION

Echinacea consumption can effect on viral disease prevention and treatment. As a result, medications or/and pharmaceutical supplements can be obtained from isolation and purification of secondary metabolites of derivatives Echinacea, for prevention and treatment of liver diseases. It is worth mentioning, more research should be conducted about the effective value of pistachios in the treatment of viral disease patients, application of Echinacea derivatives on various types of viral diseases, isolation and purification of Echinacea secondary metabolites and design and production of medications and pharmaceutical supplements with evaluation of their effects on viral disease.

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