Original Research Article

A COMPREHENSIVE REVIEW ON ANTI-INFLAMMATORY ACTIVITY OF ECHINACEA PURPUREA AND ECHINACEA ANGUSTIFOLIA

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Abstract:
Echinacea purpurea, sometimes referred to as purple coneflower, is well-known and has a long history of usage in traditional medicine for a variety of illnesses. A well-known medicinal herb called Echinacea purpurea has attracted interest for its conceivable anti-inflammatory capabilities. A wide range of experiments that were carried out both in vitro and in vivo are covered in this review's comprehensive evaluation of the literature already available on the topic. The study opens by emphasizing the rising incidence of inflammatory disorders and the need for efficient natural treatments. It looks into the phytochemical makeup of Echinacea purpurea, highlighting its bioactive elements such alkamides, polysaccharides, and flavonoids, which have proven anti-inflammatory potential via a variety of pathways. The plant has a wide variety of bioactive components, which may contribute to its possible anti-inflammatory capabilities. These components include phenolic compounds, alkamides, polysaccharides, and flavonoids. With a focus on its mechanisms of action, preclinical and clinical research, and prospective therapeutic uses, this review seeks to completely analysis techniques the scientific data demonstrating Echinacea purpurea's anti-inflammatory effectiveness. Echinacea purpurea has anti-inflammatory properties, supporting its promise as a natural treatment for inflammatory diseases.

Keywords: Anti-Inflammatory, Antioxidant, Antiviral, Antibacterial and antifungal.

INTRODUCTION:

Echinacea is a common type of all-natural immunostimulant. According to reports, echinacea enhances the production of proinflammatory cytokines and free radicals by neutrophils and macrophages by increasing their phagocytosis**.** As an anti-inflammatory, echinacea is also used[1,2]. In American Eclectic Dispensatory, John King first introduced the herb Echinacea angustifolia L. to western medicine in 1852[3]. Native Americans utilize the natural remedy echinacea to strengthen the immune system[4]. In Europe, US, and Australia, research on the utilization of Echinacea purpurea as a phytochemical and decorative plant has been done[5,6]. Indigenous First Nations healers have long employed a variety of various species for ethnomedical purposes, mainly for

thrush, sore throats, and illnesses affecting the chest, throat, and cough[7]. Echinacea purpurea, Echinacea angustifolia, and Echinacea pallida are the three species that are most frequently found in herbal remedies[8]. The endocannabinoid system (ECS) is a complex signaling mechanism that controls a range of physiological activities in both the central nervous system and the peripheral nervous system, including the regulation and control of inflammatory and allergic reactions[9]. It is common knowledge that echinacea purpurea and echinacea angustifolia preparations are used to treat upper respiratory infections. It is believed that a large portion of their benefits are a result of its immunomodulatory qualities, including actions on cannabinoid receptor[10,11]. The anti-inflammatory properties have been proven utilizing mouse inflammatory models, such as carrageenan-induced paw edema and abraded skin[12,13,14]. Therefore, we made the decision to look into the potential antiparasitic capabilities of many standardized commercial Echinacea preparations. Additionally, since we are aware that Echinacea can reduce inflammation in cells that have been exposed to a variety of viruses and bacteria[15,16,17]. Echinacea preparations' immunodulatory activity has been examined in vitro in an effort to provide insight on the mechanism of action, with research predominantly concentrating on macrophages and epithelial cells. Production of pro-inflammatory cytokines, chemokines, and lipids occurs during respiratory viral infection as a result of activation of several host pattern recognition receptors (PRRs) on macrophages and epithelial cells. The well-known symptoms of respiratory infections, such as fever, malaise, excessive mucus production, and anorexia, are brought on by these molecules' binding to receptors on a range of cell types in a number of organs and tissues[18,19]. Because of this, several researchers have proposed that the alleged alleviation offered by Echinacea extracts results from prevention of the generation of pro-inflammatory mediators. This theory has been explored in vitro by incorporating Echinacea extracts into cultures of macrophages and epithelial cells and observing the effects on inflammatory mediator production. Sadly, the outcomes of these trials have likewise been murky and inconsistent[20].

MATERIALS AND METHODS:

Echinacea sources:

Commercially produced specimens of Echinacea purpurea and E. angustifolia, members of the sunflower family Asteraceae, were obtained from North American producers. Following a recent taxonomic revision, they were recognized[21]. Echinaforce (A. Vogel Bioforce AG, Switzerland), a 65% ethanol extract of newly harvested aerial sections of Echinacea purpurea blended with 5% E. purpurea roots, was used as the test ingredient. This formulation, which lacked polysaccharides in most cases, contained the caffeic acids and alkylamides caftaric acid, chlorogenic acid, cichoric acid, cynarin, and echinacoside[22].

Echinacea and extracts:

Echinacea liquid extract (fresh Echinacea root juice, mature seed, fresh leaf juice, and fresh fruit juice extracted in 44 - 50% alcohol, Herb Pharm, Williams, OR) and dried root and leaf capsules containing 250 mg of echinacea (both available from Whole Food Market in Austin, TX) were also purchased. The solid powder was either dissolved in distilled water or pure alcohol (25 mg dry powder/ml of solvent) while the liquid extract was utilized directly. The extract was left to stand at 4 jC for 24 hours before the undissolved residue was removed by centrifugation and the soluble

fractions were employed in subsequent tests[23]. polysaccharide-rich aqueous extracts without alkylamides. Derivatives of caffeic acid were detected in agreement with predicted compositions[24]. The extract is made up of the following substances and is presented as a cream of the water-in-oil emulsion type: Citrus Aurantium Dulcis Peel Extract, Zinc Stearate, Benzyl Alcohol, Echinacea Purpurea Root Extract, Magnesium Sulfate, Lecithin, Tocopherol, Ascorbyl Palmitate, Glyceryl Oleate, Glyceryl Stearate, Citric Acid, Hexyldecanol, and Hexyldecyl Laurate are all included in this formula[25].

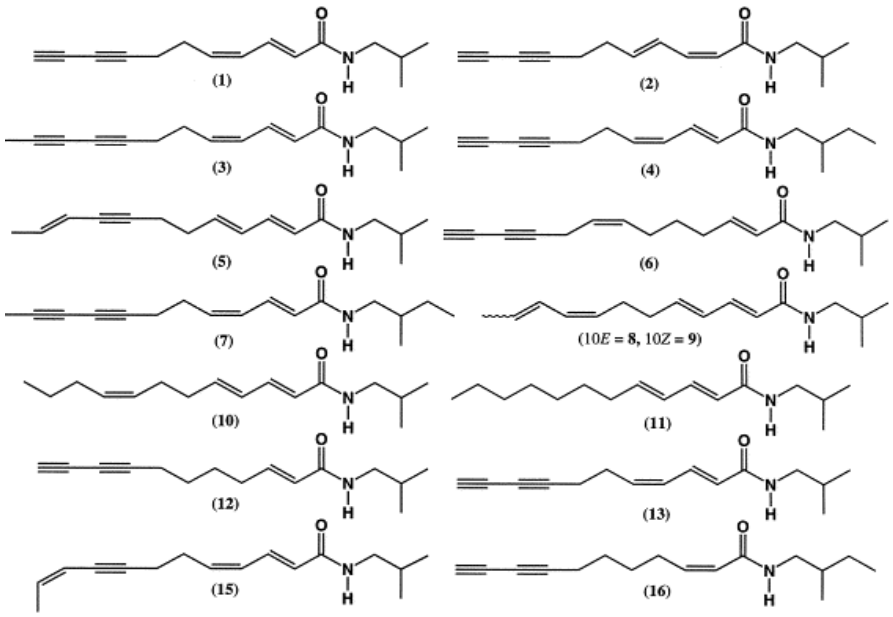
Fig. 1: Echinacea Purpurea & it's Extract.

PHYTOCHEMICAL:

The chemical composition of echinacea varies depending on the species and the portions of the plant. It is commonly accepted that no one element or collection of constituents is accountable for the actions of echinacea. Alkamides, caffeic acid derivatives, polysaccharides, and alkenes (such polyenes) appear to be a few classes of ingredients that contribute to activity[26,27].

Alkamides:

There are at least 20 alkamides, the majority of which are isobutylamides of fatty acids with straight chains and olefinic or acetylenic linkages[28,29].The main lipophilic components of the roots of E. purpurea and E. angustifolia are naturally occurring alkylamides (also known as alkamides). In the roots, there are a variety of different alkylamides, mostly isobutylamides containing C11–C16 straight-chain fatty acids with olefinic or acetylenic linkages, or both; the highest concentration is in E. angustifolia, followed by E. purpurea, and the lowest is in E. pallida. Isomeric dodeca-2,4,8,10-tetraenoic acid isobutylamides make up the major alkamide combination[30,31]. Quantitatively and qualitatively, the alkamide concentration fluctuates during the course of E. purpurea's life cycle, progressively reducing in the aerial portions and rising in the roots as the plant ages[32,33].



Phenylpropanoids:

Caffeic acid derivatives from Echinacea species have been documented, including echinacoside, des-rhamnosylverbascoside, and 6-O-caffeoylechinacoside, as well as cynarin, cichoric acid, caftaric, chlorogenic and isochlorogenic acids, and others[34]. Cichoric acid is the main active ingredient present in E. purpurea's roots and flowers, with concentrations ranging from 1.2 to 3.1% and 0.6-2.1% of dry weight, respectively. Cichoric acid is also found in smaller levels in E. pallida and E. angustifolia[35,36]. The roots of E. angustifolia are said to contain cynarin, but not those of the other two species[37,38].

Polysaccharides:

It has been demonstrated that polysaccharides (inulin, arabinorhamnogalactans, and heteroxylans) extracted from echinacea promote the activation of immune cells and have anti-inflammatory effect[39,40]. E. purpurea herb and E. pallida root contain polysaccharides and glycoproteins. Inulin-type fractions, heterogeneous polysaccharides, and an acidic, highly branched arabinogalactan polysaccharide are all found in the juice that has been pressed from the aerial sections of E. purpurea[41]. Fructose and fructan polymers are also found in echinacea. In contrast to E. angustifolia, which underwent this process later in the season, E. purpurea had a rise in total fructosan content throughout the winter. The aerial sections of E. purpurea had a 10 times lower fructan content than the roots, whereas the leaves and stems of E. angustifolia had almost no fructan at all. Additionally, fructans were discovered in homeopathic tinctures[42].

Volatile oils:

The three species' aerial portions provide volatile oils that include borneol, bornyl acetate, germacrene D, caryophyllene, and other substances. These substances are unstable and easily oxidize to 8-hydroxy derivatives. Compared to E. angustifolia, which mostly contains alkylketones, the alkenes of E. pallida and E. purpurea root are noticeably different[43].

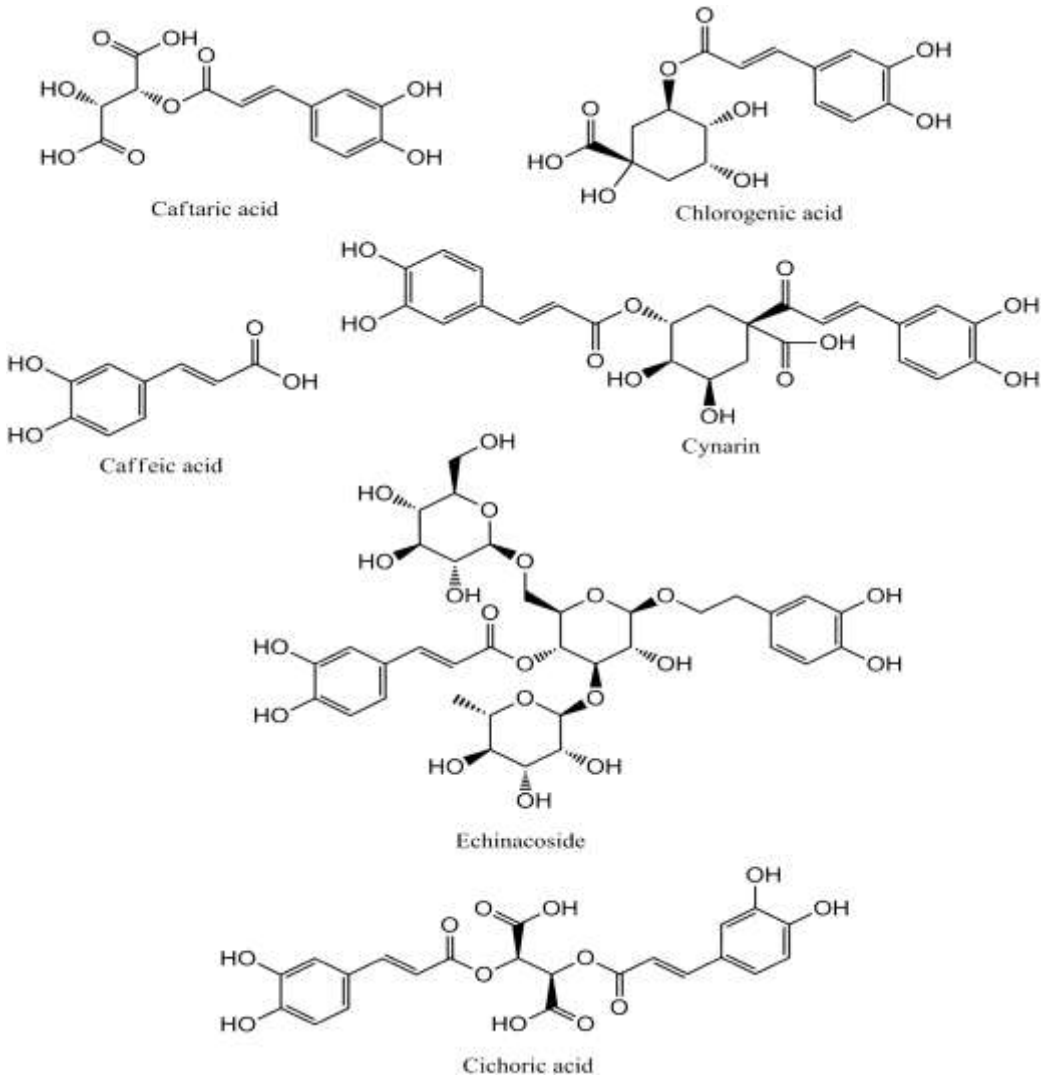
Other Constituents:

In addition to the published Echinacea constituents, it is thought that reducing sugars, phytosterols, a group of n-alkanes, and inorganic components (potassium, calcium, magnesium, iron (III), aluminum sulphate, carbonate, chloride, and silicate) also contribute to the pharmacological activity of Echinacea[44]. It has been possible to separate free phenolic acids from the aerial sections of E. angustifolia and E. purpurea, including p-coumaric, p-hydroxybenzoic, and protocatechuic acids. Vanillin, betaine, fatty acids, simple sugars, sterols, and other unrelated substances have also been identified[45].

PHARMACOLOGICAL ACTION:

Anti-Inflammatory Activity:

One of the most common Echinacea species used for medicine is Echinacea purpurea, which has been used for centuries to cure infections, speed up the healing of wounds, and boost immunity. Strong anti-inflammatory compounds found in echinaceas include alkamides and derivatives of caffeic acid[46,47]. In the carrageenan-induced rat paw oedema test and the croton oil mouse ear test, the polysaccharide fraction derived from the roots of E. angustifolia has been shown to have in-vivo anti-inflammatory effect. The polysaccharide fraction was applied topically and intravenously, respectively[48]. Echinacea extracts used topically have long been used to speed up the healing of wounds. The hyaluronic acid-polysaccharide combination that results in the indirect inhibition of hyaluronidase and the stimulation of fibroblast development is thought to be the mechanism by which the polysaccharide fraction (echinacin B) seems to improve wound healing[49,50]. It has been demonstrated that echinacea extracts block the enzymes necessary for the production of chemical mediators that promote inflammation[51]. An in vitro research conducted in 1994 revealed that an extract of the roots of E. angustifolia inhibited the enzymes cyclooxygenase and 5-lipoxygenase, which are responsible for producing the pro-inflammatory eicosanoids prostaglandin E2 and leucotriene B4 respectively[52]. The presence of alkamides in the Echinacea extracts was thought to be responsible for their inhibitory impact on these enzymes. The isobutylamides from the roots of Echinacea purpurea and E. angustifolia also prevent the conversion of arachidonic acid to inflammatory prostaglandines, which may be responsible for part of the anti-inflammatory properties of echinacea[53]. Cichoric acid, cynarine, and other chemicals from E. angustifolia show anti-hyaluronidase action, which may lessen inflammatory changes in injured tissues[54]. It has been suggested that Echinacea may be useful in preventing sun damage to skin since many Echinacea ingredients have shown to protect collagen from degradation after exposure to free radicals[55].



Antioxidant activity:

The plant extracts' capacity to absorb free radicals was examined in certain experiments[56,57]. Comparable antioxidant properties between this plant and the alkamides and cichoric acid that make up Echinacea. The extracts' ability to scavenge free radicals was associated with the presence of cichoric acid, whereas alkamides had no such ability[58,59]. Echinacea purpurea is a Lipophilic alkamides and water soluble caffeic acid derivatives make up the majority of the natural compounds found in alcohol extracts. The anti-hyaluronidase action of caffeine acid derivatives makes them potent antioxidants in systems that produce free radicals[60,61]. Other studies of the plant's root extract indicated antioxidant activity, which may be attributable to the phenolic contents and cichoric acid in the plant[62,63]. Although it was discovered that the plant's extract lacked any antioxidant properties, the plant itself does contain phenols and cichoric acid. Comparable to flavonoids and rosmarinic acid in terms of its ability to effectively scavenge free radicals from 2,2-diphenyl-1-picrylhydrazyl (DPPH), choric acid[64].

Antibacterial and antifungal activity:

Extracts of E. purpurea significantly inhibited the growth of Candida albicans and Saccharomyces cerevisiae, but no zone of inhibition was observed for Aspergillus niger. The extract obtained by the classical method showed higher antibacterial activity than the extract obtained by the ultrasonic-

assisted extraction method[65]. N-hexane extracts of E. purpurea roots have been shown to have activity against numerous yeast strains, including Saccharomyces cerevisiae and Candida albicans. Near UV light irradiation caused antifungal activity to be seen, albeit in some cases it was also light independent[66].While Acinetobacter baumannii, Bacillus cereus, Bacillus subtilis, Enterococcus faecalis (vancomycin-resistant), Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa is relatively resistant, two fungi, C. albicans and Trichoderma viride, were essentially resistant to the botanical preparation in another study[67].

Antiviral activity:

Antiviral activity has been shown for many kinds of Echinacea formulations. In tests involving the addition of glycoprotein-containing fractions produced from the roots of E. purpurea in rat spleen cell culture, ONE "Indirect" antiviral effect was seen[68]. Echinacea contains higher percentages of activity that prevents viral infection[69]. It has been proven that a polysaccharide produced from Echinacea purpurea stimulates macrophage activity, a number of cytokine production-related processes, and the synthesis of groups of phenolic compounds and alkamides, which have, respectively, antiviral and antifungal effects[70,71,72,73]. Echinacea purpurea was effective in preventing or treating upper respiratory infections (URIs)[74]. The effectiveness of Echinacea in preventing colds brought on by a cultured rhinovirus was recently tested in a human experiment, according to Turner and colleagues. Echinacea purpurea and HIV have not been linked in any reports[75].

CONCLUSION:

Echinacea preparations have the ability to regulate the proliferation of these parasites, and in at least one instance, they can suppress the inflammatory activity that is brought on by them. Although they had varying degrees of relative potency, all Echinacea preparations impeded the development of the organisms, and in certain cases, morphological alterations were seen. Echinacea purpurea's capacity to reduce inflammation. Echinacea purpurea has promising anti-inflammatory qualities through a variety of pathways, which makes it a valuable option for therapeutic treatments, according to a thorough study of research data. human bronchial epithelial cells and human skin fibroblasts, however in both instances the standardized ethanol extract of E. purpurea (L.) Moench (Echinaforce) eliminated the stimulation, demonstrating this extract has anti-inflammatory properties. The growth of these parasites can be slowed down by echinacea extracts, and at least one of them can counteract their pro-inflammatory effects.

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