

Echinacea purpurea as a medicinal plant: characteristics, use as a biologically active component of feed additives and specialized foods (review)

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Abstract. Medicinal plants are widely used in the nutrition of farm animals. In addition, the active components of medicinal plants have always been an important source of the ingredient composition of pharmaceuticals and specialized food products, including biologically active additives. However, the study of their molecular pharmacology presents a particular challenge, since they offer a wide chemical diversity of active substances with different multipharmacological activities. The purpose of this study is to analyze the scientific developments of recent years on the use of preparations and functional products based on *Echinacea purpurea* in medicine and nutrition, taking into account the distribution and availability of *Echinacea purpurea* as a medicinal plant. *Echinacea* stimulates the immune system, reduces blood sugar, anxiety and inflammation, improves skin health, has anti-cancer properties, and may serve as a viable alternative to chlorhexidine. Suggested dosages depend on the form of *echinacea*. It can help prevent colds, shorten their duration or relieve symptoms, and be effective as a preventative treatment for CoV. *Echinacea* is considered safe and well tolerated when used under controlled conditions. It may be one of the most promising herbal remedies for improving the immunity of various types of farm animals and humans.

Keywords: *Echinacea purpurea*, immunity, preventive treatment.

1 Introduction

Medicinal plants, including *echinacea*, are widely used in pharmacology and nutrition. «*Echinacea* is a genus of nine species of herbaceous plants in the Asteraceae family commonly referred to as the purple pineal. All of them are endemic to North America. They have large, showy heads of compound flowers that bloom from early to late summer. The genus name comes from the Greek "echino", meaning "spiny", referring to the spiny central disc» [1]. Some species are used as medicinal herbs, others are grown in gardens for their vibrant colors.

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Of the nine species, only three are used as herbal supplements: *Echinacea purpurea*, *Echinacea angustifolia* and *Echinacea pallida*. Both the upper parts of the plant and the roots are used in the form of tablets, tinctures, extracts and teas [1].

Native Americans have used echinacea for centuries to treat various ailments. The plant was introduced into cultivation in 1692. In Russia, *Echinacea purpurea* was introduced at the beginning of the 19th century as an ornamental plant. Currently used for the production of more than 30% of all drugs. Numerous studies have been carried out to assess the impact of the biological and immune activity of *Echinacea purpurea* on the body of animals and humans [2].

2 Materials and method

A search of materials in the electronic databases of Google Scholar, PubMed and ScienceDirect was carried out. The method of comparative analysis was used to study the scientific literature on the problem.

3 Results and discussion

Echinacea contains a wide variety of biologically active compounds, such as caffeic acid, alkalamides, phenolic acids, rosmarinic acid, polyacetylenes, and others [3].

Echinacea is rich in plant antioxidants that protect cells from oxidative stress, which is associated with chronic diseases such as diabetes, heart disease, blood vessels, etc. These antioxidants include flavonoids, chicory and rosmarinic acids [4]. These compounds accumulate, as a rule, in the fruits and flowers of plants, compared with other parts such as leaves and roots [5, 6, 7]. In addition, plants contain compounds with synergistic properties - alkalamides, which additionally enhance antioxidant activity [8].

Basically, echination is used for its immunomodulatory, anti-inflammatory and antioxidant antiviral properties, especially in the prevention and treatment of upper respiratory tract infections. The pharmacological action of echinacea is due to the presence of several groups of biologically active components, including alkalamides (lipophilic alkalamides), water-soluble phenolic compounds (mainly derivatives of caffeic acid), polysaccharides, benzalkonium chloride. Authors Kumar, K.M. & Ramaiah, S. [9] believe that the effectiveness of echinacea has not yet been fully disclosed. According to available data, echinacea has no side effects. However, further studies and surveillance are needed to establish the safety profiles of various echinacea preparations. Safety issues include the possibility of an allergic reaction, dose-dependent side effects and overdose.

Currently, various formulations containing stabilized or dried pressed *Echinacea purpurea* juice as an active ingredient are often used to treat colds. Allergic reactions can occur as reversible skin reactions, especially in people with hypersensitivity. Preparations from pressed juice of echinacea purpurea stimulate innate immunity, increase resistance to colds. «Made from the pressed juice of flowering aerial parts, they are most commonly used as immunomodulators, which are prescribed for the maintenance treatment of common viral infections of the upper respiratory tract» [10]. The results of clinical studies indicate that the «preparations used can reduce the severity and duration of colds, including in children. The main parts of the mechanism of action are the stimulation of macrophages and the induction of cytokines and glycoproteins / polysaccharides and alkalamides are part of the components relevant to its implementation» [11].

Thus, echinacea extracts have traditionally been used to heal wounds, improve the immune system and treat respiratory symptoms caused by bacterial infections. At the same time, targeted antioxidant and antimicrobial properties are demonstrated [12].

Polinacea preparation was developed, a highly standardized extract from the roots of *Echinacea angustifolia* with a specific phytochemical profile (presence of complex polysaccharide IDN5405, echinacoside phenylethanoid without alkaloids). It has been proven that Polinacea can be used to improve the immune response to the influenza vaccine [13].

Proper functioning of the immune system and its balance are essential to prevent the occurrence of a large number of diseases. Available data indicate an increase in the number of immunological pathologies, so the attention of scientists is focused on the development of preparations and specialized products that can modulate the immune response. There is a need for new effective treatments for these diseases and researchers open up new areas in solving this important problem. One promising strategy is the use of herbal medicines as adjunctive and preventive therapy. Scientists from Italy analyzed the immunomodulatory/anti-inflammatory activity of *Echinacea* spp. and *Curcuma longa*, focusing on some issues in phytochemical research and possible strategies for obtaining new agents in addition to existing treatments [14].

A group of Iranian researchers have proven that echinacea solution is effective in reducing oral microbial flora. Given the advantages of the synergistic properties of the components of echinacea, it can be proposed as a viable alternative to chlorhexidine [15].

Data obtained by scientists from Taiwan show that chicory acid has a targeted inhibitory effect on the growth of colon cancer cells, presumably by reducing telomerase activity and inducing apoptosis. The exact mechanism of action remains to be determined in future studies. The studied effects of a 50% aqueous ethanol extract of *E. purpurea* flowers and chicoric acid can serve as evidence of their use in vitro as chemotherapeutic agents [16]. Potential cytotoxic and proapoptotic properties of the hexane extract of the root of three medicinal species of *Echinacea* (Asteraceae) (*Echinacea pallida* (Nutt.) Nutt., *Echinacea angustifolia* DC. Var. *Angustifolia*, *Echinacea*) in vitro *purpurea* (L.) Moench.) were studied on cell lines of pancreatic cancer and human colon cancer. All three species reduced cell viability depending on concentration and time. These results represent a starting point for further research on the role of echinacea in medical oncology [17].

Hungarian scientists studied the psychotropic effects of echinacea by evaluating the anxiolytic potential of five different echinacea preparations. Three of them reduced anxiety, two had a narrow range of effective doses [18]. *E. purpurea* extract has been shown to have good potential for the treatment of hyperglycemia and hypertension [19]. There is evidence that *E. purpurea* flowers contain compounds capable of managing insulin resistance and type 2 diabetes [20].

Dietary supplements made from natural plant extracts have advantages over their many synthetic counterparts. They have a mild therapeutic effect without pronounced side effects. Thus, echinacea extracts can be recommended as components of functional and dietary nutrition [21].

Coronaviruses (CoVs) were long thought to cause only mild respiratory and gastrointestinal symptoms but outbreaks of Middle East Respiratory Syndrome (MERS)-CoV, Severe Acute Respiratory Syndrome (SARS)-CoV and identified SARS-CoV-2 have bolstered their zoonotic potential and the ability to cause morbidity with a fatality rate of 2 to 35%. Nowadays there is no specific prevention or treatment for CoV infections. Swiss scientists investigated the antiviral potential of *Echinacea purpurea* (Echinaforce®) against human coronavirus (HCoV) 229E and highly pathogenic MERS- and SARS-CoVs in vitro. HCoV-229E was found to be irreversibly inactivated when exposed to Echinaforce at an IC50 of 3.2 µg/mL. However, pre-treatment of cell lines did not inhibit HCoV-229E infection and post-infection treatment had only a minor effect on virus replication at 50 µg/mL. However, a protective effect was observed in the organotypic respiratory cell culture system, when the respiratory epithelium was pretreated under conditions of exposure to HCoV-229E and simulated natural infection. Antiviral activity was not limited to cold coronaviruses, as highly pathogenic SARS- and MERS-CoV were inactivated at comparable concentrations. These results suggest that

Echinacea purpurea preparations such as Echinaforce may be an effective means of preventing and treating CoV, including newly emerging SARS-CoV-2 strains [22].

Intensification of livestock production based on the use of feed antibiotics has raised concerns that this leads to the development of antimicrobial resistance and poses a potential threat to human health. The use of feed antibiotics has been a common and well-established practice in animal husbandry, which has contributed to the intensification of this branch of agriculture since the discovery of antibiotics in the 1920s. The search for alternatives to antibiotics in animal production has intensified in recent years due to tightening regulations regarding the use of growth promoters and increased consumer demand for animal products grown without antibiotics. Ideal alternatives to antibiotics should have the same positive effects as antibiotics. They should ensure optimal performance of the animals and increase the availability of nutrients, have a positive effect on feed conversion and growth [23]. In recent years, many scientists and practitioners working in the field of animal nutrition have turned their attention to phytobiotics, natural bioactive compounds derived from plants and included in animal feed to increase productivity. Echinacea purpurea may be one of the most promising herbal remedies for improving the immunity of various species of farm animals and humans [24, 25, 26, 27].

4 Conclusions

It can be concluded that the popularity of Echinacea purpurea is associated with its availability and effectiveness due to the high content of biologically active substances and targeted action. Echinacea improves immunity, reduces blood sugar levels, anxiety, inflammation, improves skin health, has anti-cancer properties and can be effective as a prevention and complex treatment of CoV.

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