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Invasive alien species: potential cheap resources of plant substances for medicinal use*

Abstract

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On the basis of the literature examined, the scientific acquisitions concerning the pharmacological properties and medicinal uses of *Ambrosia artemisiifolia* and *Erigeron canadensis* – two American vascular plants of Asteraceae family that have become invasive in Europe and others continents – are collected and discussed. The data reveal the potential of the invasive as cheap sources of compounds with valuable pharmacological activities. In addition to the two plants presented as a case study, there are hundreds of plant species at hand as potential assets to explore and make money.

Key words: *Ambrosia artemisiifolia*, *Erigeron canadensis*, *Asteraceae*, biologically active compounds, pharmacological activity, management, ecosystem services.

Introduction

Some alien plant species have high tolerance of various habitat conditions and elevated propagation ability. This promotes their aggressive invasive behaviour. Often they over compete the local vegetation. Additionally many of them suppress the seed germination and seedling development of local plants. In the newly invaded habitats they might not have suitable herbivores to control their populations (DAISIE 2009). The only effective enemy might be *Homo sapiens*. Humans are known with their destructive power once an object has become significant for industrial utilization. Due to the fact that these are aggressive invasive species, they can provide abundant and cheap resources of plant bioactive compounds which can be used for medicinal purposes. Additionally, excessive harvesting for medicinal use might contribute to decrease their populations and reduce the destructive impact of these species on natural habitats.

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The good practice in the traditional use of plants for remedial purposes is a precondition for successful phyto-therapeutic application. On these basis a modern scientific approach such as phytochemical and pharmacological investigations affirms the therapeutic effect.

Echinacea purpurea (L.) Moench. is an example of a plant with growing modern popularity based on good practices in Native Americans' traditional medicine (Austin 2004, Wilkes 2012).

The aim of this contribution is to review research data and reveal the potential of two invasive plants of *Asteraceae* family as cheap sources of compounds with valuable pharmacological activities.

Material and metods

On the basis of the literature examined, the scientific acquisitions concerning the pharmacological properties and uses of *Ambrosia artemisiifolia* L. and *Erigeron canadensis* L., two American species that have become invasive on different continents, are collected and discussed. Some brief botanical, distributive and ecological indications on these two species are given below.

Ambrosia artemisiifolia is an annual plant native to North America across Canada, the eastern and central United States, the Great Plains, and in Alaska; the Caribbean on Cuba, Hispaniola, and Jamaica; and South America in the southern bioregion (Argentina, Chile, Paraguay, Uruguay), the western bioregion (Bolivia, Peru), and Brazil. This species has been introduced in Europe at the end of 19th century in seed crops at various independent geographical points and at various times since its introduction in natural habitats. Recently, the number of naturalized populations increased considerably fast and it is considered to be the one of the most dangerous invasive alien species of Europe (Chauvel & al. 2006; Kazinczi & al 2008; Essl & al. 2009; DAISIE 2009; Hodgins & al. 2013).

Erigeron canadensis [= *Conyza canadensis* (L.) Cronquist] is an erect, annual plant. It is native throughout most of North America and Central America and invasive in Europe. It was introduced into Europe in the mid 17th century, likely along with Canadian furs shipped to France (Tilley 2012). This plant is associated with disturbed, open and unshaded habitats, such as cultivated land, abandoned fields, roadsides, ruderal places, and other open habitats. Canadian horseweed can reduce crop yields through direct competition for resources. (Tilley 2012). It also contains allelopathic chemicals which can inhibit germination and reduce seedling growth in several species (Shaukat & al. 2003).

On the two plants chosen as a case study (*Ambrosia artemisiifolia* and *Erigeron canadensis*), here we present: 1) traditional ethnobotanical data from their native habitats; 2) modern investigations of pharmacological activity and essential secondary compounds.

The case studies

Ambrosia artemisiifolia (Fig.1).

This species contains phytotoxins and shows significant inhibitory effects on the seed germination and primary growth of crops (Ritter & Coble 1981; Wang & Zhu 1995;

Fig. 1. Drawing of *Ambrosia artemisiifolia* from Bulgarian population (by E. Kozuharova).

Brückner & al. 2003; Vidotto & al. 2013). High levels of naturally occurring variation in the ALS gene sequence have been found in *A. artemisiifolia* allowing rapid and widespread selection for resistance when ALS-inhibiting herbicides are used (Tranel & al. 2004). The main problem is that its pollen is well known as noxious allergen (Mirone & al. 2004; D'Amato & al. 2007; Léonard & al. 2010).

There are different therapeutic effects known to the Native Americans, which are well documented (Gilmore 1913; Speck 1941; Tantaquidgeon 1972; Hamel & al. 1975; Herrick 1977; Shemluck 1982; Anderson & al 1988; Austin 2004, Table 1).

Table 1. Ethnobotanical data and therapeutic effects of *Ambrosia artemisiifolia* known to the Native Americans.

Tribe	Therapeuti effect	Method of application	References
Cherokee	Dermatological Aid	Crushed leaves rubbed on insect sting and infusion of leaf rubbed on hives.	Hamel & al. 1975, Moerman 1998
	Disinfectant	Juice of wilted leaves applied to infected toes.	Hamel & al. 1975 Moerman 1998
	Febrifuge	Infusion of leaf taken for fever.	Hamel & al. 1975 Moerman 1998
	Pulmonary Aid	Infusion taken for pneumonia.	Hamel & al. 1975 Moerman 1998
Dakota	Antidiarrheal	Infusion of leaves and plant tops taken for bloody flux.	Gilmore 1913 Moerman 1998
	Antiemetic	Infusion of leaves and plant tops taken for vomiting.	Gilmore 1913 Moerman 1998
Delaware	Blood Medicine	Poultice of plant used to prevent blood poisoning.	Tantaquidgeon 1972, Moerman 1998
Houma	Gynecological Aid	Decoction of root taken for menstrual troubles.	Speck 1941, Moerman 1998
Iroquois	Antidiarrheal	Compound decoction of plants taken for diarrhea with bleeding.	Herrick 1977, Moerman 1998
	Heart Medicine	Infusion of roots taken for stroke.	Herrick 1977, Moerman 1998
	Orthopedic Aid	Decoction of plants taken for cramps from picking berries.	Herrick 1977, Moerman 1998
Lakota	Antirheumatic (External)	Infusion of leaves applied to swellings.	Rogers 1980, Moerman 1998
		Plant used for toilet paper.	Rogers 1980, Austin 2004, Moerman 1998
Luiseno	Emetic	Plant used as an emetic.	Sparkman 1908, Moerman 1998
Mahuna	Dermatological Aid	Infusion of plant used as a wash for minor skin eruptions and scalp diseases.	Romero1954, Moerman 1998
Oto	Antiemetic	Bruised leaves laid on scarified abdomen for nausea.	Gilmore 1919, Moerman 1998

It contains sesquiterpenoids-sesquiterpene lactones, etc. (Bianchi & al. 1968; David & al. 1999; Sturgeon & al. 2005; Taglialatela-Scafati & al. 2012; Huang & al. 2014; Ding & al. 2015; Kiss & al. 2017) as well as polyphenols and flavonoids (Parkhomenko & al. 2005, 2006; Maksimovic 2008) or other constituents (Georgiev & al. 2007).

Pharmacological tests revealed that *Ambrosia artemisiifolia* possess numerous activities such as cytotoxic, antimalarial, antimicrobial, anti-inflammatory, pronounced hepatoprotective and hypolipemic-lowers the concentration of fats in the blood (Table 2).

Principal constituents of the essential oil obtained by steam destilation are germacrene D (24.1%), limonene (16.83%), α-pinene (8.0%) and myrcene (7.4%) with significant bactericidal and fungicidal activity (Chalchat & al. 2004, Table 2).

Table 2. Pharmacological activities of *Ambrosia artemisiifolia*.

Activity of the plant extracts	Reference
Antioxidant	Maksimovic 2008
Hypolipemic	Parkhomenko & al. 2005, 2006
Hepatoprotective	Parkhomenko & al. 2005, 2006
Cytotoxic	Bianchi & al. 1968; David & al. 1999; Sturgeon & al. 2005; Huang & al. 2014; Kiss & al. 2017
Antimalarial	David & al. 1999
Antimicrobial: antifungal, antibacterial, antiviral	Georgiev 2007; Solujić & al. 2008
Anti-inflammatory	Pérez 1996
Activity of the essential oil	
Significant bactericidal and fungicidal activity	Chalchat & al. 2004

Erigeron canadensis (Fig. 2).

Ethnobotanical investigations reveal that there are number of therapeutic effects known to the Native Americans (Moerman 1998, 2009; Pennacio & al. 2010; Austin 2010, Table 3). It is claimed that in folk medicine this plant is used in diarrhea, dysentery uterine hemorrhages, dropsy, gravel, cystitis, calculus, bronchial catarrh, and hemoptysis (Yan & al. 2010, Shakirullah & al. 2011) but there is no indication for original native American tradition Phytochemical studies revealed that *Erigeron canadensis* contained saponins, diterpenoids, terpenoids, glycosides, tannin, anthraquinone, steroids and flavonoids (quercetin-7-O-beta-D-galacto pyranoside,quercetin, luteolin, apigenin, 5,7,4'- trihydroxy-3'-methoxy flavone, quercetin-3-alpharhamnopyranoside, quercetin-3-O-beta-Dglucopyranoside, apigenin-7-O-beta-D-gluco pyranoside, luteolin-7-O-beta-D-glucuronide methyl ester,4'-hydroxy baicalein-7-O-beta-Dglucopyranoside, baicalein and rutin). Also conyzolide; conyzoflavone; conyzapyranone A; conyzapyranone B; 4 Z,8 Z-matricaria- γ-lactone; 4 E,8 Z-matricaria- γ-lactone; 9,12,13-trihydroxy10(E)-octadecenoic acid; epifriedelanol; friedeline; taraxerol; simiarenol; spinasterol; stigmasterol; β- sitosterol; C10 acetylenes; sesqui-

Table 3. Ethnobotanical data and therapeutic effects of *Erigeron canadensis* known to the Native Americans.

Tribe	Method of application	Therapeutic effect	References
Native Americans	smoke the flowers and leaves	for pleasure or to relive head colds.	Pennacio & al. 2010
Native Americans		gastointestinal aid	Moerman 2009
Chumash	grind the plant tea	relive pain kidney problems	Austin 2010
Navajo	crush leaves to	treat skin problems	Austin 2010

Table 4. Pharmacological activities of *Erigeron canadensis*.

Activity of the plant extracts	Reference
Antioxidant (potent radical scavenging activity)	Olas & al. 2006; Saluk-Juszczak & al. 2010; Shah & al. 2012; Park & al. 2013
Anti-platelet and anticoagulant	Olas & al. 2006; Saluk-Juszczak & al. 2010; Pawlaczyk & al. 2011
Antiinflammatory	Lenfeld & al. 1986, Sung & al. 2014
Antiproliferative	Réthy 2007; Réthy & al. 2007; Csupor-Löffler & al. 2009, 2011
Anti-gastric ulcer	Park & al. 2013
De-pigmentation	Hong & al. 2008
Antibacterial	Biswas & Sinha 2014
Reduce blood glucose level in vitro	Aslam & al. 2018
Activity of the essential oil	
Anti-inflammatory	Guenter 1976
Haemostatic	Guenter 1976
Stimulant	Guenter 1976
Carminative	Guenter 1976
Antiproliferative	Choi 2008,
Antifungal - evaluated to weak	Curini & al. 2003
Antifungal - evaluated to moderate or strong activity against *Candida, Cryptococcus, Trichophyton, Rhodotorula* but no antibacterial activity	Veres & al. 2012
Anti-melanoma B16 activity	Yan & al. 2010

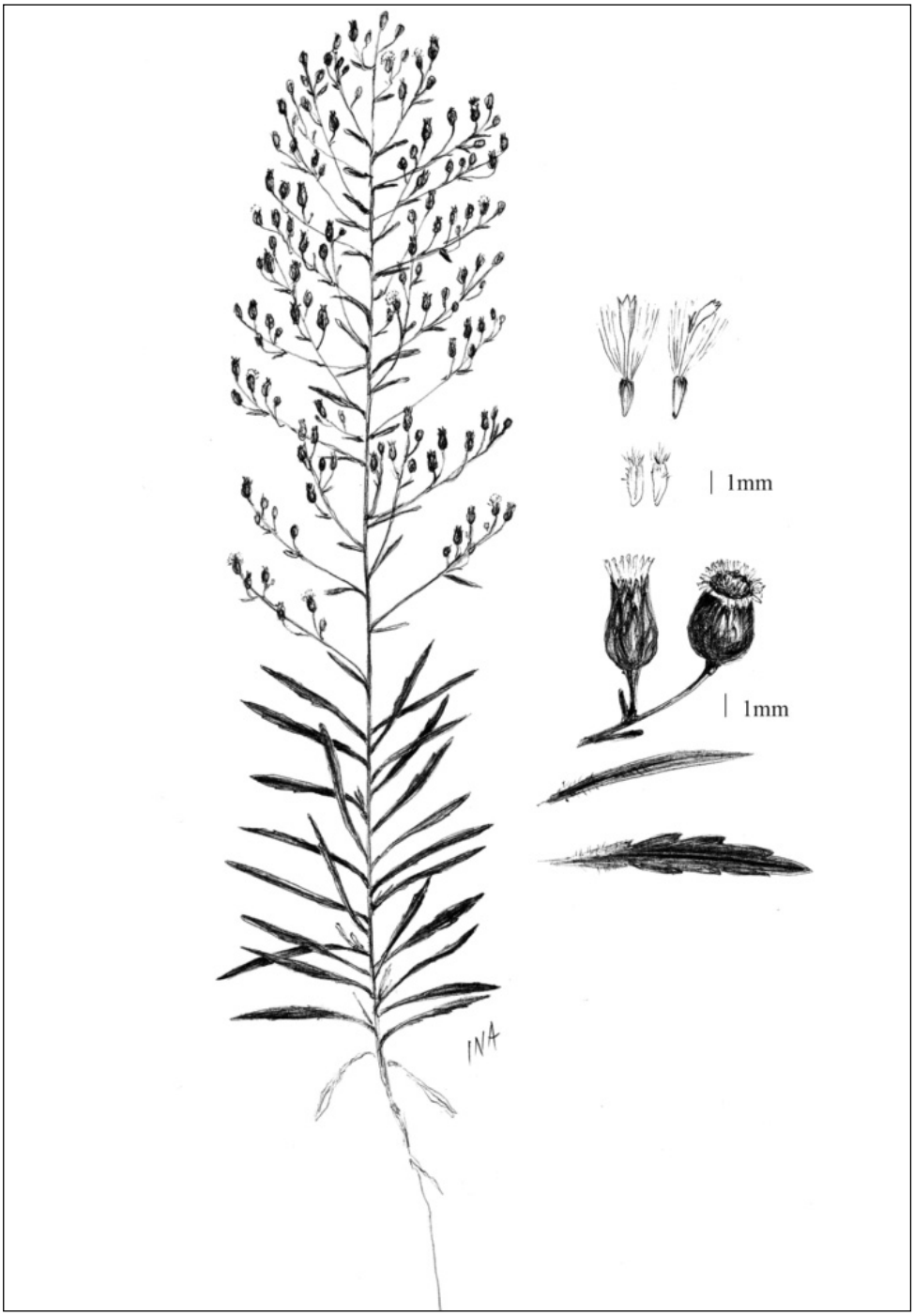

Fig. 2. Drawing of *Erigeron canadensis* from Bulgarian population (by E. Kozuharova).

terpene hydrocarbons, beta-santalene, beta-himachalene, cuparene, alpha-curcumene, gamma-cadinene, sphingolipids 1,3,5-trihydroxy-2-hexadecanoyl amino-(6E,9E)-heptacosdiene; 1,3,5-trihydroxy-2- hexadecanoylamino-(6E,9E)-heptacosdiene-1-Oglucopyranoside; 1,3-dihydroxy-2-hexanoylamino- (4E)-heptadecene; p-hydroxybenzoic acid, 3,5- dihydroxybenzoic acid, 3,5-dimethoxybenzoic acid; 3beta-hydroxyolean-12-en-28-oic acid; 3beta-erythrodiol; beta-sitosterol; stigmasterol; beta-sitosterol 3-O-beta-D-glucoside and harmine were isolated from different parts of the plant (Bohlmann & Jakupovic 1979; Lenfeld & al. 1986; Czeczot & al. 1990; Mukhtar & al. 2002a, 2002b; Wei & al. 2007; Shakirullah & al. 2011; Csupor-Löffler & al. 2011; Shao 2012; Shah & al. 2012; Veres & al. 2012; Biswas & Sinha 2014).

Extracts of *Erigeron canadensis* were reported to have anti-inflammatory and anti-proliferative activity as well as gastric ulcer protective effect. Also anti-inflammatory, de-pigmentation, anti-coagulant, anti-platelet and anti-oxidant effects are reported (Table 4).

Health risks or side effects following the proper administration of designated therapeutic dosages were not recorded (Anonymous 2000).

The essential oil contains more than 30 constituents but is mainly composed of monoterpenoids-limomene, camphene, α and β-pinenes etc., and sesquiterpenoids – caryophyllene, germacrene D and α-curcumene etc. (Miyazawa & al. 1992; Lis & Góra 2000; Rustaiyan & al. 2004; Tzakou & al. 2005; Lis & al. 2005; Unnithan & al. 2014, Ayaz & al. 2017). A few non-terpenoid acetylenic compounds were also detected (Unnithan & al. 2014). The compounds isolated from essential oils differ among different locations which may be attributed to the different environmental and climatic conditions (Unnithan & al. 2014).

The essential oil of *Erigeron canadensis* possess anti-inflammatory, haemostatic, stimulant, carminative and antifungal activity (Table 4).

Discussion and conclusion

Ethnobotanical data from their habitats reveal promising medicinal potential. A growing body of scientific literature points to their therapeutic properties. Valuable chemical constituents of these alien invasive species are sesquiterpene lactones, essential oils etc. They posses different activities such as anticancer activity, as well as antitussive, antifungal, antiinflammatory, antinociceptive, hypoglycaemic, antimitotic, antioxidant, antitrypanosomal, CNS depressant activity, diuretic effects, contact dermatitis, insecticidal and herbicidal activities, hepatoprotective and hypolipemic activities etc.

Due to the fact that these are aggressive invasive species, they can provide abundant and cheap resources reach of plant chemical constituents which can be utilized for therapeutic purposes. Additionally, exploitation of the biomass for medicinal use might contribute to relieving the destructive impact of these species on natural habitats.

The invasive plant species considered in this contribution deserve further investigations as they have valuable pharmacological activities. Harvesting of the plants for their medicinal value may reduce the populations due to decreased seed production and propagation. This way additionally the risk of allergy caused by *Ambrosia artemisiifolia* pollen will decrease.

There are many studies conducted on the two species here examined and there is good reason to believe that there are prospects of study that can still provide other products that can

contribute to give further value to negatively evaluated biological resources, since they are seen as harmful and competitive agents and not as a resource. Therefore, unexplored fields remain to which new research can be directed. In addition to the plants presented as a case study, there are hundreds of species at hand as potential assets to explore and make money.

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