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Biologically active compounds in *Agrimoni eupatoria* L. and their therapeutic effects

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ABSTRACT

Three species from the genus *Agrimonia* occur in Poland: *Agrimonia eupatoria* L., *Agrimonia pilosa* Ledeb., and *Agrimonia procera* Wallr. *Agrimonia eupatoria* is a native plant growing commonly in meadow, scrub, and ruderal communities in lowland areas and in lower montane zones. *A. eupatoria* species have been classified as edible, cosmetic, and medicinal plants. *Herba Agrimoniae* is a medicinal raw material from *A. eupatoria* L. It is a source of many biologically active compounds, mainly flavonoids, tannins, proteins, carbohydrates, and vitamins. *A. eupatoria* herb is characterised by varied contents of groups of biologically active compounds. The *A. eupatoria* bioactive compounds exhibit antiviral, antibacterial, anti-inflammatory, anti-carcinogenic, and antioxidant activity. This rich source of health-enhancing substances is used in treatment of disorders of the gastrointestinal system and bile ducts as well as inflammatory diseases of the skin. With their antiseptic and anti-inflammatory properties, *A. eupatoria* infusions are used to alleviate throat diseases and are recommended to occupational voice users.

***Keywords*:** common agrimony, active compounds, therapeutic application, Rosaceae

1. INTRODUCTION

The family Rosaceae comprises over 300 plant species occurring worldwide, mainly in the northern hemisphere. Its taxa grow in moderate climate forests as understory species,

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saltwater and freshwater marshes, and the Arctic tundra. They are less abundant in mixed forests [1,2]. In Poland, the family Rosaceae comprises approximately 150 species of trees, shrubs, and herbaceous plants. Perennials from the family Rosaceae, subfamily Rosoideae, are represented by many medicinal species, e.g. plants from the genus *Agrimonia*[1]

The name of the genus originates from Greek *agrós* "field" and *moné* "place of living", which indicates the habitat of the plant. The term is associated with the Greek word *agremone*, which refers to plants used in the treatment of cataract[2]. Three species from the genus *Agrimonia* occur in Poland: *A. eupatoria* L., *A. pilosa* Ledeb., and *A. procera* Wallr.[3]. The plants were used already in ancient times and are still highly appreciated. Currently, growing interest in herbal therapy can be observed. Plant raw materials are being tested as potential agents to be used in prophylaxis, treatment, and mitigation of symptoms of certain diseases. The aim of the study was determine biologically active compounds in *Agrimonia eupatoria* raw material, their therapeutic properties, and application of *A. eupatoria* in phytotherapy.

2. OCCURRENCE RANGE

The common agrimony *Agrimonia eupatoria* L. occurs in the northern hemisphere, reaching the Canary Islands in the south, North Africa, and Central Asia. Additionally, the species grows in the Himalayas at an altitude from 1800 to 3500 m a.s.l. in the undergrowth of wet highland forests[4], [3]. There are several cytotypes of *A. eupatoria* (n = 14, 28, 42). Diploid forms inhabit Western Europe countries, whereas tetraploids occur in Japan and the Far East. In turn, diploid and tetraploid forms coexist in central Eurasia, e.g. in Russia [4].

In Poland, *Agrimonia eupatoria* is a native plant growing commonly in meadow, scrub, and ruderal communities across lowland areas and lower montane zones. It can also be found along forest margins and on slopes. The species is a widespread plant. In terms of the life form defined by Raunkiaer, *A. eupatoria* was classified as a nanophanerophyte[5].

3. MORPHOLOGICAL CHARACTERISTICS

The common agrimony produces spindle-shaped rhizomes and a thin, poorly branched 60-100 cm stem, sometimes with a reddish tinge. The epidermis of stems, laminas, and leaf axes bears two types of mechanical trichomes, i.e. one type is represented by long, straight, and often tangled trichomes, while short and bent hairs are the other type [5].

The odd-pinnate leaves of the species reach a length of approximately 20 cm. They are composed of 3 or 6 opposite leaf pairs with 2 or 3 smaller leaflets. The leaflets are elliptical or oval and their margin is incised-dentate and sometimes serrate. The adaxial surface of the leaf

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blades is dark green and the abaxial side is greyish and tomentose[6]. The plant blooms in July and August. Numerous flowers grow in the axilla of tripartite hairy bracts. The corolla has a diameter of ca. 6 mm. Flowers are gathered in a racemose inflorescence. The inversely conical receptacle is slightly longer than the width and furrowed along its entire length. The hypanthium bears vertical or oblique erect setae surrounding the calyx. The yellow corolla has five non-fused, easily detaching petals. There are 10-20 stamens and two pistils in the flower. One pistil is typically transformed into an achene fruit[7]. One or two achenes are present in a pendulous, closed, hard hypanthium with 10 longitudinal furrows[5] [6]. *A. eupatoria* species have been classified as edible, cosmetic, and medicinal plants [5,8].

4. BIOLOGICALLY ACTIVE COMPOUNDS

Herba agrimoniae herb is the therapeutic material from *A. eupatoria* L. It is a source of many bioactive compounds, primarily terpenes, phenolic compounds, tannins, flavonoids, proteins, carbohydrates, and vitamins (Table 1).

Table 1. Selected bioactive compounds present in *Agrimonia eupatoria* raw material

Group of bioactive compounds		**Bioactive compounds**	**Author**
Amino acids	aliphatic	alanine, arginine, aspartic acid, , cysteine, glycine, glutamic acid, isoleucine, leucine, lysine, methionine, serine, threonine, valine	[31]
	aromatic	phenylalanine ,tyrosine	
	heterocyclic	histidine, proline	
Flavonoids	flavones	luteolin	[6]
Plant organic acids	aliphatic acids	decanoic acid, nonanoic acid	[32]
Terpenes	monoterpenes	borneol, camphene, camphor, linalool, α and β-pinene, pulegone,	[6]
	monocyclic monoterpenes	eucalyptol, limonene, terpineol,	[32]
	sesquiterpenes	α-bisabolene, α and β- cedrene, τ-cadinene, caryophyllene, muurolol, α and β-selinene,	[6]

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Furanocoumarins	piranocoumarins	thymol	
Phenols	simple phenols	carvacrol, myristicin	
	phenolic acids	coumaric acid, gallic acid, protocatechuic acid	[13, 33]
	depsides	chlorogenic acid	
Vitamins		B, B_1, C, E, K, PP	[34, 35, 36]

The compounds were classified into the chemical groups in accordance with Kohlmünzer [9]

The content of the individual groups of biologically active compounds in *A. eupatoria* herb varied. Polysaccharides with strong anticoagulant properties were isolated from *A. eupatoria* [7]. The concentration of polysaccharides was 20%, hydrolysing tannins and condensed derivatives of ellagic acid and catechins were in the range of 3,1-10,8%[10] [7-9], and flavonoids accounted for 0,3-1,4% [8,10].

Phenolic acids represented 2,3% in the *A. eupatoria* herb [8,9]. Chlorogenic acid was the dominant phenolic compound (91.3%), while other phenolic compounds were present at a substantially lower concentration: gallic acid (3.9%), coumaric acid (1.8%), protocatechuic acid (1.6%), and quercitrin (1.3%) [11]. Shabana et al. [8] identified 12 phenolic acids and 13 flavonoids. The content of volatile oils was 0.2% [6].

Proteins contained in the *A. eupatoria* herb were composed of 17 amino acids. The amino acid content was 7,62 mg/100 mg of the raw material. The dominant amino acids included aspartic acid (0,9%), glycine (0,9%), alanine (0,7%), valine (0,7%), and lysine (0,5%). Besides these active compounds, the material contained phytosterols [6], mucilage [12], glycosides [6,13-15], vitamins B, B1, C, E, K, PP, and K[8] [13,16], and silica-rich mineral compounds[9].

5. PHYTOTERAPEUTIC ACTIVITY OF *A. EUPATORIA*

A. eupatoria extracts are an important source of bioactive compounds with favourable phytotherapeutic activity; for instance, they exhibit anti-HBV (hepatitis B virus) activity. Similar properties were found for *A. coreana pilosella* and *A. pilosa* extracts [3]. In turn, active compounds derived from *A. pilosa* inhibited the metabolism of influenza A and B viruses [17]. There are reports on the antibacterial activity of *A. eupatoria* extracts against pathogenic *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* bacteria and the beneficial effect on wound healing in rats [12]. Similar antibacterial activity against *Staphylococcus aureus* and α-haemolytic *Streptococci* in the healing process was detected in other studies as well [6].

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The appropriate concentration of flavonols, flavones, and phenolic acids in *A. eupatoria* extracts determines the high antioxidant capacity [9,11,18,19,20] which can be involved in the anti-inflammatory activity [16,21]. In particular, the *A. eupatoria* bioactive compounds have an anti-inflammatory effect on the gastrointestinal mucosa[9]. Consumption of tea made from the raw material of the species has a beneficial impact on improvement of markers of lipid metabolism, oxidative status, and inflammatory status in adults [15].

Tannins contained in *A. eupatoria* extracts act as astringent and anti-diarrhoeic agents, whereas flavones exert a cholagogic effect. Extracts from this raw material increase the secretion of gastric juice and have a positive influence on the liver function[8] [6]. Anti-cancer activity of the extracts was confirmed in investigations of cervical cancer [6]. It was reported in other studies that *A. pilosa* roots contained anti-tumour compounds [22,23] The raw material of this species contains polyphenol compounds, e.g. agrimonine, catechin, quercetin, and rutin. The first compound has been found to exhibit anti-tumour properties[10].

6. APPLICATION OF *A. EUPATORIA* RAW MATERIAL

The biologically active compounds contained in *A. eupatoria* have been used in treatment of many medical conditions. Oral intake of the extract is recommended in general weakness of the organism, epigastric pain, gastric and intestinal inflammation, disorders of liver function, and gallbladder atony with cholestasis[9]. The plant infusion is applied in gastrointestinal diseases, digestive disorders, diarrhoea, abdominal pain, gastritis, and enteritis. This raw material was found to have a beneficial effect in treatment of cholecystitis and cholangitis[9,11]. *A. eupatoria* can be used in achlorhydia, asitia, and flatulence[10]. External compresses with this astringent, anti-inflammatory, and antimicrobial agent help in healing varices and damaged skin. Additionally, the extract can be used as a mouthwash and for treatment of vaginal discharge. The plant is also used in treatment of pharyngitis, and rinsing the throat with a common agrimony infusion is recommended to occupational voice users (teachers, priests, and actors)[9].

Biologically active compounds contained in another species *A. pilosa* inhibited OVA-induced respiratory tract inflammation. The molecular mechanisms of strong anti-inflammatory and anti-allergic activity suggest that the analysed raw material can be a therapeutic strategy in treatment of various inflammatory diseases, including asthma [24].

A. eupatoria raw material is applied in prophylaxis and treatment of menopausal disorders and protection of the cardiovascular system in women during the period of reduced of oestrogen production [25].

In vitro tests have shown high estrogenic activity of *A. pilosa*, suggesting a possibility of application of the raw material from this species for prevention of menopausal symptoms caused by oestrogen deficiency and for treatment of postmenopausal disorders in gynaecology [26]. Antidiabetic properties of *A. eupatoria* have also been highlighted [9,27-29]. There is also an *A. eupatoria*-based drug 'Rhoival' with urological activity available in the form of tablets [30].

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7. CONCLUSIONS

The *A. eupatoria* raw material mainly contains phenolic compounds, polysaccharides, tannins, and vitamins. *A. eupatoria* is a rich source of health-enhancing compounds used for preparation of mixtures recommended for treatment of gastrointestinal and bile duct diseases as well as in external applications for alleviation of inflammatory skin conditions. Antiseptic and anti-inflammatory infusions from *A. eupatoria* are recommended to occupational voice users.

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