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Address of Editorial Board

Faculty of Pharmacy
2, Dunav str., Sofia 1000
Fax (02) 987 987 4

Editor in Chief: ✆(+359 2) 9236 505
E-mail: pharmacia_editor@pharmfac.net
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CONTENTS

ASPHODELINE LUTEA (L.) RCHB.: A REVIEW OF ITS BOTANY, PHYTOCHEMISTRY AND ETHNOPHARMACOLOGY

I. Lazarova[1], R. Gevrenova[2]

[1]Department of Chemistry, Faculty of Pharmacy, Medical University of Sofia, 2 Dunav Str., 1000, Sofia, Bulgaria
[2]Department of Pharmacognosy and Pharmaceutical Botany, Faculty of Pharmacy, Medical University of Sofia, 2 Dunav Str., 1000, Sofia, Bulgaria

Abstract. *Asphodeline lutea (L.)* Rchb. (Asphodelaceae) is a perennial, landscaping plant native to southeastern Europe and Turkey. Traditional use of the plant is limited to consumption of roots, shoots, flowers and leaves as vegetables. Recently, several groups of secondary metabolites with promising biological activity were characterized: anthraquinones, flavonoids and benzene/naphthalenes. The extracts from roots of *Asphodeline lutea L*. were evaluated for their antioxidant and anti-multidrug resistance activity. The presented review summarizes the information concerning the botany, traditional uses, phytochemistry and ethnopharmacology of *Asphodeline lutea*.

Key words: *Asphodeline lutea (L.)* Rchb., anthraquinones, flavonoids, benzene/naphthalenes, GC/MS analysis, nutritional quality, antioxidant activity, anti-multidrug resistance

Introduction

The genus *Asphodeline* Rchb., comprising 14 species, belongs to the family Asphodelaceae, subfamily Asphodeloideae. Species of Asphodeloideae have been shown to possess 1,8-dihydroxyanthraquinones based on a chrysophanol unit [1-2]. Many studies have concerned the composition of anthraquinones in medicinally important Aloe, Cassia and Rheum species [3-5]. Anthraquinone derivatives have been found in wild and cultured higher plants, mosses, lichens, fungi as well as in sea animals and algae. In fungi and lichens, these are anthracycline antibiotics and anthracyclinones. In higher plants, anthraquinones are present in oxidized, reduced, glycosided, and condensed forms, as a rule, together with their precursors. The anthraquinones possess astringent, purgative and anti-inflammatory activities. They are thought to be moderate antitumor agents due to their inhibitory effects on tumor cells. In addition, bactericide, antiviral and anti-HIV-1 effects have been reported [4]. Anthraquinones participate in the processes of metabolism, respiration, division of cells, oxidative phosphorylation, complexation with DNA and RNA, and, perhaps, in other physiological processes of vital importance [4, 6].

The present review compiles the limited information on the botany, traditional uses, phytochemistry and ethnopharmacology of *Asphodeline lutea.* This information will highlight this plant as a new source of food and biologically active compounds and will provide a new direction for researchers in the future.

1. Botanical description and occurrence

Asphodeline lutea is known by vernacular names King's Spear and Yellow Asphodel. It is a perennial, landscaping plant native to southeastern Europe and Turkey.

Steam 40-80 cm, stout, erect, entirely covered by sheathing leaf-bases. Lower leaves up to 35 cm × 1.5-3(-5) mm, narrowly linear, recurved, the upper shorter and suberect. Raceme 10-20 cm. Bracts 20-30 × 8-12 mm, ovate, cuspidate. Pedicels c.20 mm, articulated near the middle. Perianth-lobes 20-25 × 4-7 mm, greenish-yellow. Capsule 10 mm, globose; seeds 4-5 mm, trigonous, black, 2n=28. *Stony ground and dry grassland. Balkan peninsula and Aegean region, extending to Istra and S.E. Romania; C. S.Italy, Sicilia.* Al Bu Cr Gr It Ju Rm Si Tu. [7].

2. Phytochemistry

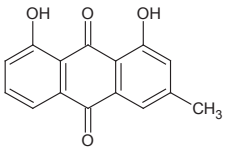
The secondary metabolites belonging to the classes of anthraquinones, flavonoids and benzene/naphthalenes have been reported in *A. lutea.*

2.1. Anthraquinones

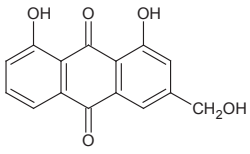
According to the literature chrysophanol **(1)** was the dominanat anthraquinone derivative present in the majority of *Asphodeline* species [8-12]. In addition, other anthraquinones including aloe-emodin

Isolated compounds from *A.lutea*

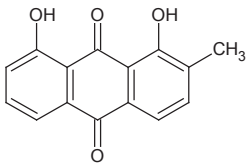
Anthraquinones



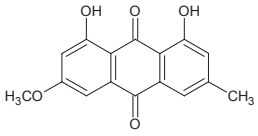
Chrysophanol (1)



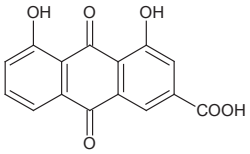
aloe-emodin (2)



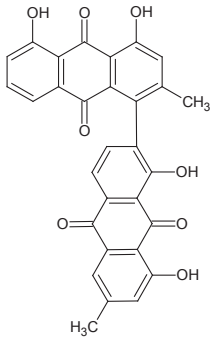
Isochrysophanol (3)



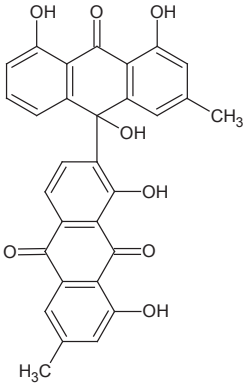
physcion (4)



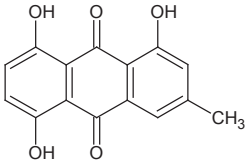
Rhein (5)



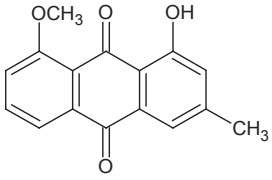
Asphodeline (6)



1,1‘,8,8‘,10-pentahydroxy-3,3‘-dimethyl-10,7‘-bianthracene-9,9‘,10‘-trione (7)

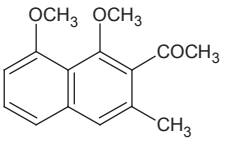


1,5,8-trihydroxy-3-methyl-anthraquinone **(8)**

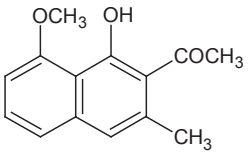


1-hydroxy-8-methoxy-3 methylanthraquinone **(9)**

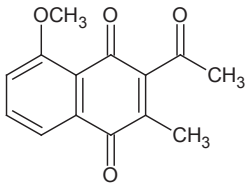
Benzene/naphthalene derivatives



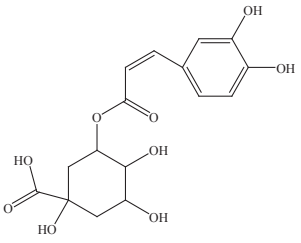
2-acetyl-1,8-dimethoxy-3-methylnaphthalene **(10)**



and 2-acetyl-1-hydroxy-8-methoxy-3-methylnaphthalene **(11)**

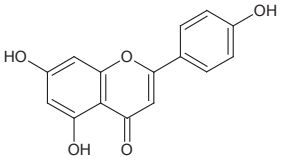


2-acetyl-8-methoxy-3-methylnaphthoquinone **(12)**

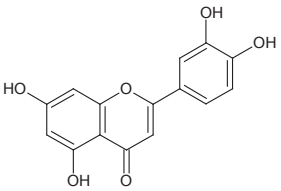


chlorogenic acid **(13)**

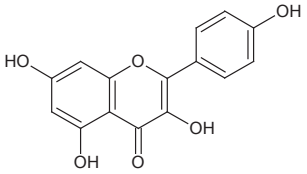
Flavonoids



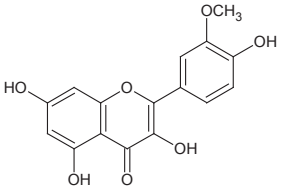
apigenin **(14)**



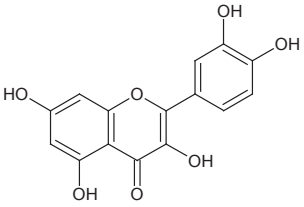
luteolin **(15)**



kaempferol **(16)**



isorhamnetin **(17)**



quercetin **(18)**

(2), isochrysophanol **(3)**, physcion **(4),** rhein **(5),** asphodeline **(6)** and 1,1',8,8',10-pentahydroxy-3,3'-dimethyl-10,7'-bianthracene-9,9',10'-trione **(7)** have also been isolated [11].

Two new anthraquinones for the genus *Asphodeline*, 1,5,8-trihydroxy-3-methylanthraquinone **(8)** and 1-hydroxy-8-methoxy-3 methylanthraquinone **(9),** as well as the known chrysophanol and asphodeline were isolated from the roots of *A. lutea* [12].

2.2. Benzene/naphthalene derivatives

Naphthalenes and naphthoquinones were isolated for the first time from this species. *A. lutea* roots was shown to contain the naphthalene derivatives 2-acetyl-1,8-dimethoxy-3-methylnaphthalene **(10)** and 2-acetyl-1-hydroxy-8-methoxy-3-methylnaphthalene **(11)** [12]. The naphthoquinone 2-acetyl-8-methoxy-3-methylnaphthoquinone **(12)** is a known synthetic compound [12-13], but the first report on its natural occurrence was in *A. lutea* roots. In addition, chlorogenic acid **(13)** has been found [11, 14].

2.3. Flavonoids

The presence of flavonoids apigenin (**14**), luteolin (**15**), kaempferol (**16**), isorhamnetin glycosides (**17**) and quercetin **(18)** has been reported in *A. lutea* [11, 14].

2.4. GC/MS analysis of the volatiles from different parts of *Asphodeline lutea*

The volatile compounds from flowers, aerial parts and roots of *A. lutea* were analyzed by GC/MS. Several differences were observed in the qualitative and quantitative pattern of hydrocarbons derivatives, as reported by Ivanova et al. (2010). In general, the content of hydrocarbons was higher in the flowers than those in roots and aerial parts. In particular, the compounds with the highest content were heptacosane and nonacosane. One chlorine-containing compound, 1,1,2,2-tetrachloro-ethane, with expected antimicrobial activity was found in the flowers. Phenethyl alcohol with antimicrobial activity was detected in the aerial parts and roots. A significant amount of acetic acid was found in the roots. As regards naphthalene derivatives, the highest content of 2,3-dimethoxynaphthalene was detected in the aerial parts, while 2-Acetyl-3-methyl-1,8-dimethoxynaphthalene is presented in flowers and roots [15].

3. Ethnopharmacology

3.1 Edible use and nutritional quality of the protein in the leaves of *Asphodeline* (*Liliaceae*) species

There are limited data about the biological activity of *A. lutea*. However, the edible use of its roots, shoots, flowers and leaves has been known for a long time [16]. The ancient Greeks roasted the roots like potatoes and ate them with salt and oil or mashed them with figs. The raw fresh flowers are very decorative and a tasty addition to salad, while the young shoots are eaten cooked. Several *Asphodeline* species, including *A. lutea, A. cilicica, A. damascena, A. globifera,* and *A. taurica*, are consumed in salads in different regions of Turkey. The nutritional quality of the protein in the leaves of 11 *Asphodeline* species, including *A. lutea, A. anatolica, A. cilicica, A. globifera, A. damascena ssp. Damascene, A. damascena ssp. rugosa, A. peshmeniana, A. prismatocarpa, A.*

rigidifolia, A. sertachae, A. taurica, A. turcica was investigated by the determination of the amino acid composition and calculation of several nutritional parameters - amino acid score, protein efficiency ratio, predicted biological value. The protein in the leaves of the *Asphodeline* species is characterised in general by a good nutritional quality as determined by comparison of amino acid composition with FAO recommendations, although it is for most taxa deficient in sulphur amino acids and Lysine. Nutritional parameters were also high and above those reported for the seed proteins of other Mediterranean edible plants. Thus, the leaves of *Asphodeline* represent a good source of proteins of good nutritional value in addition to functional compounds, such as polyphenols and dietary fibre [2].

3.2. Antioxidant activity

The extracts from roots of *Asphodeline lutea L.* were evaluated for their antioxidant properties [17]. The chloroform and ethyl acetate extracts from *A. lutea* manifested an excellent antioxidant activity during autoxidation of triacylglycerols of lard (TGL) and triacylglycerols of sunflower (TGSO). The antioxidant effect increased with rising concentration of the extracts. The chloroform and ethyl acetate extracts at 0.5% concentration improved the oxidation stability of native sunflower oil in a much lower degree (stabilization factors 1.4 and 1.2 respectively) compared to stabilization factors for BHT, α-tocopherol (Toc) and ferulic acid (FA) (0.02%). The compound 2-acetyl-1-hydroxy-8-methoxy-3-methylnaphthalene isolated from chloroform extract was found to be active as antioxidant.

3.3. Anti-multidrug resistance activity

The ability of extracts from roots of *Asphodeline lutea L.* to inhibit P-gp dependent transport activity in mouse lymphoma cell line overexpressing the MDR1 gene was studied by flow cytometry using the standard functional assay with rhodamine 123 as a fluorescent substrate analogue. The chloroform extract from *A. lutea* showed promising levels of MDR-reversing activity and might restore the drug accumulation in cancer cells by inhibiting the Pgp-mediated efflux pump. The tumour-specific cytotoxic action of the methanol extract from the same plant was demonstrated. This extract was shown to enhance the drug retention in the cells by inhibiting the efflux-pump activity (fluorescence activity ratio for 0.4 and 4 μg/ml was 1.39 and 43.98, respectively) [18].

In conclusion, the results apparently indicate the existence of therapeutically useful substances and the chemotherapeutic value of *Asphodeline lutea*.

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✉ **Corresponding author's contacts:**
Medical University – Sofia, Faculty of Pharmacy,
Department of Cemistry,
Tel.: +35929236513
e-mail: airi_airi@abv.bg