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Review Article

REVIEW OF THE CURRENT STATUS OF STUDY *OXYTROPIS*

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ABSTRACT

The use of plants for medical purposes has been known since ancient times, and despite progress in the synthesis of medicinal products, herbal remedies continue to occupy a significant place in modern medicine. As promising sources of biologically active substances of natural origin, attention is attracted by representatives of the domestic flora from the family *Fabaceae.* The article gives an analysis of the current state of the study of the genus of *Oxytropis* and shows the prospects for their comprehensive study. Work in the herbarium fund of the Institute with a collection of species of *Oxytropis glabra* Lam. DC. allowed to identify the presence of at least 10 herbarium sheets. While analyzing the internet sources, we collected materials on the genus and species of *Oxytropis* which have been investigated for many years. When analyzing internet resources, it was established that the widely used traditional Tibetan, Chinese, Mongolian, and Buryat medicine should include representatives of the genus *Oxytropis* (DC.) of the family *Fabaceae (L.).*We have studied the species of the *Oxytropis* and compiled a table on their chemical composition and pharmacological action.

Keywords: *Oxytropis, Oxytropis glabra* Lam. DC., *Leguminosae,* Papillionoideae, Locoweed, Official, Traditional medicine, Chinese, Tibetan, Flora of Kazakhstan.

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INTRODUCTION

Plants used for traditional medicine contain a wide range of substances that can be used to treat chronic as well as infectious diseases [1]. *Oxytropis* is an important genus of the family *Fabaceae* (L.) and the subfamily Papillionoideae, also known as "Locoweed." More than 350 species of locoweeds are common in the temperate and arctic regions of the Northern Hemisphere, where the main centers of species diversity are concentrated in Central and Central Asia, in Southern Siberia, in the Altai and the Far East of Northeast Asia. Locoweeds grow mainly in mountain meadows and steppes, stony slopes, in the arctic and alpine tundra. They occur on the stony slopes of the Tien Shan and the Central Sayan Mountains, in the mountain steppes of Northeast Yakutia [2].

Oxytropis genus includes both arcto-alpine species confined to stony habitats, rocks and tundra of the Arctic region and the Alpine belt of mountains, and steppe forms connected with steppe groupings. Some of them (*Oxytropis chankaensis* Jurtz, *Oxytropis gmelinii* Fisch. ex Boriss., and *Oxytropis baschkirensis* Knjasev) were investigated on the territory of Russia [3]. Turkish botanists Seher Karaman Erkul and Zeki Aytac conducted an audit of species of the genus *Oxytropis* growing in Turkey [4,5]. In Kamchatka, Cholinas *et al.* investigated the genetic variations of six species of local locoweeds [6]. In one of his works, Malyshev presented a system analysis of the genus *Oxytropis* in Asian Russia [7]. According to his data, 142 species and 24 subspecies in 5 subgenera and 16 sections were found in Siberia and the Russian Far East, of which, as the author notes, 15 taxa are unjustifiably identified as independent species. The work also presents data on the number of chromosomes, plant patterns, and the area maps. Yu and Zibzeev analyzed the ontogenetic and vital structure of seven populations of the endemic species of alpine meadows of Altai *Oxytropis sulphured* (Fisch. Ex DC.) Ledeb. in various cenotic conditions of the highlands of the Rudny Altai (the Ivanovsky and Prohodnoy ranges) and the Saur [8].

A great work devoted to the Tien Shan locoweeds, their composition, botanical-geographical relations, morphological characteristics, and economic significance was done by Abdulina. According to her data, 119 species from 15 sections of the *Oxytropis* genus were recorded in Kazakhstan, of which 36 species 32.5% are endemic and 10 are listed in the Red Book.

Many types of *Oxytropis* are of practical importance as feed, melliferous, medicinal, and ornamental plants. Hence, *Oxytropis deflexa* and *Oxytropis glabra* are fodder on natural pastures. Cultivation of these species is promising. Other species of the genus are melliferous, such as *Oxytropis lapponica* and *Oxytropis pilosa*, and some species can be used as decorative (for example, *Oxytropis pilosa*). *Oxytropis tragacantoides*, which has the life form of a shrub, traditionally is used as fuel in the republics of Tyva and Altai of the Russian Federation and in Mongolia [9].

Herbal medicine has been commonly used over the years for treatment and prevention of diseases and health promotion and quality of life. However, there is a lack of a systematic approach to assess their safety and effectiveness. The holistic approach to health care makes herbal medicine very attractive to many people in worldwide.

Table 1: The economically significant characteristics of the *Oxytropis*

View	Decorative	Fodder	Medicinal
O. campanulata Vass.	+	–	Tradition
O. deflexa (Pallas) DC.	+	+	Tradition
O. filiformis DC.	+	+	Tradition
O. glabra (Lam.) DC.	+	+	Tradition
O. lapponica (Wahkend.) J. Gay	+	+	-
O. muricata (Pallas) DC.	+	+	Tradition
O. pilosa (L.) DC.	+	Toxic	Tradition
O. setosa (Pallas) DC.	+	+	Tradition
O. strobilacea Bunge	+	+	-

O. campanulata: Oxytropis campanulata, O. deflexa: Oxytropis deflexa, O. filiformis: Oxytropis filiformis, O. glabra: Oxytropis glabra, O. lapponica: Oxytropis lapponica, O. muricata: Oxytropis muricata, O. pilosa: Oxytropis pilosa, O. setosa: Oxytropis setosa, O. strobilacea: Oxytropis strobilacea

The medicinal value of these plants lies in bioactive phytochemical constituents that produce definite physiological action on the human body. Some of the most important bioactive phytochemical constituents are alkaloids, essential oils, flavonoids, tannins, terpenoids, saponins, phenolic compounds, etc. Several herbal secondary metabolites such as flavonoids have been found to protect cells from oxidative damage [10].

Medicinal plants containing flavonoids, as the basis of its composition, are widely used species of the *Oxytropis* in Tibetan and folk medicine: *Oxytropis falcate, Oxytropis myriophylla, Oxytropis ochrocephala,* and *O. pilosa* (L.) DC.

The total flavonoid glycoside was isolated from *O. falcata*, could enhance the secretion of adrenal cortex hormones, and induce a large number of these hormones being released into the peripheral blood stream. In simple terms, the total flavonoid glycoside of *O. falcate* could activate the hypothalamus-pituitary – adrenal axis; improve the body stress to achieve expectorant, anti-inflammatory effect.

Table 2: Chemical components of the species of the *Oxytropis*

Species	Extracts and methods	Chemical compounds
O. falcate Bunge.	The chloroform extract of *O. falcata* was analyzed by HPLC-MS. HPLC was performed on a 4.6*250 mm Diamonsil C18 column packed with 5 um particles (Dikma, Beijing, China) at a flow of 1 mL/min, of which 250 uL/min was shunting for the mass spectrometer. The gradient was from 5% mobile phase: B containing CAN and 0.1% formic acid (both HPLC-grade, Sigma-Aldrich) to 35% Bin 25 min, followed by a washman free equilibration step the ethyl acetate extract of *O. falcate*	N-benzoyl-phenylethylamine, 7-hydroxy-flavonone, 2',4'-Dihydroxy chalcone, N-benzoyl-Hydroxyl phenylethylamine, 2',4'-Dihydroxy dihydrochalcone, anagyrine, lupanine, N-cinnamoyl-2-phenylethylamine, 7-methoxyflavonone, 2'-methoxy-4'-hydroxychalcone, 2'-hydroxy-4'methoxychalcone, 2',4',4-trihydroxychalcone, Pinocembrin, glycyrrhizin, formononetin, pinostrobin 5-hydroxyl-7-methoxyflavanone, ψ-baptigenin, Oxytropine C, rhamnetin, m-Methoxyaniline, 2-monolinolein, Kaempferol (3-O-(6'- acetyl)-β-D-glucoside, β-daucosterol, anagyrine. phenethylamine, 7-hydroxyflavone, 7-hydroxy-flavanon naringenine, naringetol, apigenin, 2',4'-dihydroxychalcone, phenyl ethyl, chrysin, isoliquiritigenin, salicin, naringenin, luteolin, quercetin, 2,4-dihydroxy-4'-dimethoxychalcone, kaempferol, 5,7-dihydroxy-4'-methoxy-hydroxy-2 phenyl, 3,7-Dihydroxy-2',4'-dimethoxyisoflavan, isorhamnetin, β-sitosterol, myricetin, kaempferide-7-O-β-D-glucopyranoside, β-daucosterin, 5,7-dihydroxy-4'-methoxy-2-phenyl-4-benzopyr, methoxy-2-phenyl-4-benzopyrone-3-0-β-galactopyranoside, 7-oxositosterol, 7α-hydroxysitosterol, 5,6-dihydroxy-2,7,3',42 tetramethoxy flavone [15,16]
O. ochrocephala	The ethanol extract of *O. ochrocephala* was analyzed by HPLCMS (Thermo Fisher, San Jose, CA LCQ). HPLC was performed on 4.6*250 mm Diamondsil C18 column packed with 5 um particles (Dikma, Beijing, China) at a flow of 1 mL/min, of which 250 uL/min was shunting for mass spectrometer. The gradient was from 5% mobile phase B containing ACN and 0.1% formic acid (both HPLC-grade, Sigma–Aldrich) to 35% B in 25 min, followed by a wash and equilibrations step	7-methoxy flavonone, 2',4,4'-trihydroxychalcone, pinocembrin, 2'-hydroxy-4'-dimethoxy chalcone, fermononetin, glycyrrhizin, 2'-methoxy-4'-hydroxychalcone, N-benzoyl-phenyl ethylamine, N-cinnamoyl-2-phenylethylamine, 7-methoxyflavanone, 5-hydroxy-7-methoxyflavanone, 2-monolinoleoyin, Chrysin, Genistein, Apigenin, luteolin, 3,7-Dihydroxy-2',4' dimethoxyisoflavan, 7-Hydroxyflavone, isoliquiritigenin, isorhamnetin, quercetin, myricetin, kaempferol, phenyl ethyl, phenethylamine, genistein, salicin, 7α-hydroxysitosterol, 5,7-dihydroxy-4'-methoxy-hydroxy-2-phenyl, and 5,7-Dihydroxy-4'-methoxy-2-phenyl-4-benzopyrone-3-O-β-galactopyranoside [17]
O. myriophylla	The powders of *O. myriophylla* were extracted with 95% EtOH. The extract was suspended in water and extracted successively with EtOAc, n-BuOH. The *n*-BuOH soluble part was separated on D101 macroporous resin, silica gel, Rp-18 silica gel, Sephadex LH-20 column chromatography, and HPLC to obtain compounds. The phytochemical study of 70% ethanol extract obtained from the whole plant of *O.myriophylla* afforded compounds. The structural elucidations of all the compounds were based on extensive spectroscopic methods, including HRESIMS and 2D-NMR experiments (HSQC, HMBC, 1H–1H COSY, and HSQC-TOCSY), UV	(6*R*,9*R*)-roseoside,(6*R*,9S)-roseoside,adenosine, quercetin-7-*O*-α-L-rhamnopyranosyl-3-*O*-(60-*P*-coumaroyl) -β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside, quercetin-7-*O*-α -L-rhamnopyranosyl-3-*O*-(60-caffeoyl) -β-D-glucopyranosyl-(1→2)-β -D-xylopyranoside, kaempferol-7-*O*-α-L -rhamnopyranosyl-3-*O*-(60-*P*-coumaroyl) -β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside, quercetin-7-*O*-α -L-rhamnopyranosyl-3-*O*-(60-feruloyl) -β-D-glucopyranosyl-(1→2)-β-D-xylopyranoside, quercetin-7-*O*-α-L-rhamnopyranosyl-1-3-*O*-(60-*P*coumaroyl) -β-D-glucopyranosyl-(1→2)-β-D glucopyranoside, myriophylloside B, myriophylloside C, myriophylloside D, myriophylloside E, myriophylloside F[18] isorhamnetin-3-0-β-D-glucoside, isorhamnetin-3-0-α-L-arabinosyl (1→6) -β-D-glucoside, quercetin, rutin [19]

O. falcate: Oxytropis falcate, O. myriophylla: Oxytropis myriophylla, O. ochrocephala: Oxytropis ochrocephala

Table 3: Some medicinal plant raw materials of the genus *Oxytropis* (DC.) of the *Fabaceae (L.)* family

Species	Guideline in red books	Used in	Chemical composition	Pharmacological properties
1	2	3	4	5
O. falcate Bunge.	The Republic of Tajikistan, 2011	Traditional Chinese medicine	Saponins, alkaloids, flavonoids, coumarins	Treat inflammation, flu, pain, stop bleeding, and anthracosis [22]
O. pilosa (L.) DC.	The Republic of Belarus, 2014, the Republic of Mari El 2013, the Republic of Sakha (Yakutia) 2000, the Republic of Estonia 2008	Folk medicine	Phenolcarbonic acids, alkaloids, coumarins, and the following flavonoids: Quercetin, mono- and diglyco-sides of quercetin, and kaempferol, as well as astragalin	Applied for neuroses, neurasthenia, fever, vegetovascular dystonia, with some gynecological diseases and inflammation of the appendages [23]
O. myriophylla (Pall.) DC.	-	Traditional Chinese and folk medicine	Coumarins, alkaloids, flavonoids (ramnezine, ramnetin, and their glycosides), essential oil	Cardiovascular diseases, blood-resurfacing, diuretic, antipyretic, anti-inflammatory, pain-relieving [24]
O. muricata (Pall.) DC.	The Republic of Tuva in 2009, the Krasnoyarsk region, 2012	The Mongolian medicine	Resins, alkaloid, chemical composition is not studied enough	Has strong sedative, narcotic, tonic, anti-inflammatory, wound-healing and antimicrobial action. Encyclopedia of medicinal plants [25]
O. lanata (Pall.) DC.	Transbaikalian Region 2014, the Republic of Sakha (Yakutia) 2000	Tibetan medicine	Saponins, triterpene soyasapogenin, alkaloids, phenolcarboxylic acids, astragaline, myricetin, rhamnetin, rhamnazin	Hemostatic, antipyretic, and diuretic agents [25]
O. oxiphylla (Pall) DC.	-	Chinese and Tibetan medicine	Coumarins, essential oils, alkaloids, and the following flavonoids: rhamnetin, rhamnazin, and their glycosides.	Cardiovascular diseases, ascites, anthrax [25]
O. glabra Lam. DC.	The Republic of Bashkortostan 2011, The Republic of Sakha (Yakutia), 2000	Tibetan medicine	Saponins, alkaloids, Vitamins C, P, carotene, diuretic flavonoids	Hemostatic, antipyretic, anti-inflammatory, analgesic, cardiovascular, depressing central nervous system, with ascites and edema [26]
O. almaatensis Bajt.	Kazakhstan	Folk medicine	Phenolcarboxylic acids, flavonoids	Coronary-expanding, hypotensive [27]
O. deflexa (Pall.DC.)	-	Oriental medicine	Saponins triterpene, alkaloids, flavonoids	Painkillers for intoxication and septicopyemia [27]

O. falcate: Oxytropis falcate, O. pilosa: Oxytropis pilosa, O. myriophylla: Oxytropis myriophylla, O. lanata: Oxytropis lanata , O. muricata: Oxytropis muricata, O. oxiphylla: Oxytropis oxiphylla, O. glabra: Oxytropis glabra, O. almaatensis: Oxytropis almaatensis, O. deflexa: Oxytropis deflexa

. The parts of the plant that have traditionally been used in folk medicine are the rhizome and plant. It is traditionally used for detoxification, anti-inflammation, pain relief, astringent pulse, removal of heatÿproduce muscle fibers, and cure sores. It is also used for the treatment of Malaria, hemorrhage, constipation, anthrax, topical treatment of tonsillitis, eliminating blood stasis, and remove osteoma. It controlled bleeding with astringents and improved tissue regeneration including blood vessel. *O. falcate* Bunge, called the "King of Herbs"("Chinese Materia Medica" editorial committee, 1999; Liu,1997), is the main material used to prepare a variety of Tibetan medicinal compounds and traditional Tibetan medicine, as well as more mainstream clinical medicine. In China, *O. falcate* Bunge, locally known as "E da Xia," was first recorded in the Chinese Pharmacopoeia as an official herbal drug in 1977 [11].

O. myriophylla (Leguminosae) is an important Mongolian medicine, widely distributed in the southeast and northwest areas of China. It has traditionally been used to treat various diseases of rubella and influenza and applied to swelling and throat pain, together with different types of bleeding. Pharmacological research on this plant showed antioxidant and anti-inflammatory properties [12].

O. ochrocephala is one of the most extensively used herbs in traditional Tibetan folk medicine to clear heat through detumescence, strengthen the body, and improve immune system [13].

O. *pilosa* (L.) DC is one of the *Oxytropis* species that are known as the "King of Herbs" in Chinese Tibetan medicine. However, some *Oxytropis* species contain very toxic indole alkaloids. Current knowledge about the antioxidant properties of *O. pilosa* (L.) DC is not supported by the available reference date [14]. The chemical components and methods are listed in Table 2.

Currently, the pharmaceutical industries are facing many challenges and favoring the use of plant natural products over the current chemo-clinical drugs available for the treatment of different diseases. Development of resistance to commercial antimicrobial drugs due to abuse of these drugs, the reemergence of dangerous infectious diseases, high production costs, and limited effective lifespan of the synthetic therapeutic agents are important factors that have encouraged a widespread interest in drugs derived from plant extracts [20].

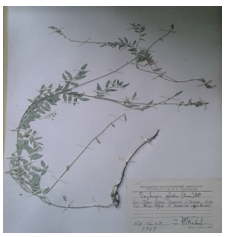
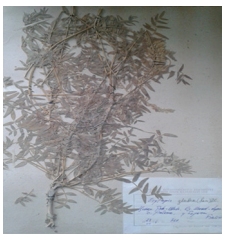
Some representatives of this genus, such as the *Oxytropis oxiphylla* and *Oxytropis strobilacea,* proved to be promising for the pharmaceutical industry. An extract containing biologically active flavonoid compounds, on the basis of which the preparation "Oxophil" for the treatment of rhinitis, possessing antihypoxic, analgesic, and anti-inflammatory action, and also contributing to the restoration of the affected tissues, was obtained from the aboveground part of *O. oxiphylla* [21].

Table 4: List of samples of *O. glabra* Lam. DC. collected in the Balkhash region, and collections of *O. glabra* Lam. DC. from the herbarium of the Institute of Botany and Phyto-Intrusion (1908-1956)

No.	Place of collecting	Date of collecting	Collections from herbarium fund	Collectors
1	Irkutsk region, Balaganskiy district, surroundings of Sherbakova village, meadow	12.08.1908		N. Maltsev
2	Taldy-Kurgan Uyezd, Karatal, and Martam-Kum	18.07.1928		V.I. Smirnov
3	Balkhash-Alatau, Eastern Balkhash region, lowland area, the middle part of the Lepsy, and Baskan-Cul lake	29.07.1934		I.A. Limchevsky O.A.Limchevsky
4	DzhungarAlatau, the foothill plain, Samarkand between the rivers Baskankul and Aksu	25.06.1934		I.I. Rubtsov
5	Issyk-Kola Basin 10 km to 103 from Rybalchy, Kyrgyz SSR	01.08.1938		A. Rubanok
6	Eastern Balkhash, Aghramant mountains height 710 in a dry gorge	24.06.1960		Z.I. Polduchin
7	On the sandy shore of Issyk-Kul near Rybachye	08.07.1948		N.I. Rubtsov

Contd...

Table 4: (*Continued*)

No.	Place of collecting	Date of collecting	Collections from herbarium fund	Collectors
8	Western Tien Shan, the Chatkal river valley closer to Yangi-Taraz village	03.08.1962		V. Palov
9	The Central Tien Shan, lake Issyk-Kul, at the Rybachye shore	23.08.1986		B. Baitenov

O. glabra: Oxytropis glabra

When analyzing the internet resources, it was established that the widely used traditional Tibetan, Chinese, Mongolian, and Buryat medicine should include representatives of the genus *Oxytropis* (DC.) of the family *Fabaceae* (L.).

Table 3 shows that the species of the *Oxytropis* are widely used in Chinese, Tibetan, traditional, and oriental medicine.

A review of literary sources showed that in the countries of the near abroad popular cultivated species are: *O. glabra* Lam. DC. successfully cultivated in the CSB SB RAS (Novosibirsk); *O. gmelinii* Fisch. ex Boriss. - cultivated and studied in the BSI URC RAS (Ufa) since 1997, in the collection there are 4 samples; *Oxytropis hippolyti* Boriss. - successfully cultivated in the BCC UNSC RAS (Ufa), introduced into the Park forestry (Ufa); *Oxytropis kungurensis* Knjasev - successfully cultivated in the Ural Branch of the Russian Academy of Sciences (Ekaterinurg), stable, 5 samples being studied; and *Oxytropis sordida* Willd. Pers. - introduced into the CSI of the URC RAS (Ufa) with seeds of 2004 [28].

Of the approximately 6000 vascular plants growing in the flora of Kazakhstan, over 1500 species are characterized by medicinal properties; most of them are used in folk medicine. Such a little studied and unused in official medicine plant in Kazakhstan is a wild medicinal plant *O. glabra* Lam. DC [29,30].

A review in the herbarium fund of the Institute with a collection of species of *O. glabra* Lam. DC. allowed to identify the presence of at least 10 herbarium sheets.

Thus, the analysis of the herbarium fund made it possible to reveal the state and amount of the collection, the geography, the collecting time, and the collectors.

The phytochemical composition of the *O. glabra* Lam. DC. is not sufficiently studied. To obtain a new domestic phytopreparation, medicinal plant raw materials should cover in depth information. Under this work have been isolated two new compounds of triterpenoid saponins: 3-0-[-β-D-glucopyranosyl (1-2)-β-D-glucuronopyranosyl] azukisapogenol methyl ester and 3-0-[-β-D-glucopyranosyl(1-2)-β-D-glucuronopyranosyl] azukisapogenol amide *O. glabra* Lam. DC. In the chemical composition of *O. glabra* Lam. DC., there are alkaloids, which are poisonous in the period of vegetation and feed in the flowering period. The toxic property of the alkaloid was first investigated in the work of Baisheva and Rong-man *et al*. [31]. Foreign scholars have come a long way to discover the ingredients of locoweed and significant effort has been devoted to their study for nearly a century. They found that the toxic ingredients of locoweed could be divided into three groups: aliphatic nitro compounds, selenium or selenium compounds and locoweed toxin. The alkaloids, which have already been isolated and identified from locoweed, can be divided into 3 groups according to their structures: Indolizidine alkaloids (swainsonine and nitrogen oxide swainsonine), quinolizidine alkaloids (anagyrine, thermopsine, lupinine and n-methylcytisine) and piperidine alkaloids. These alkaloids were also isolated from the genus *Oxytropis*: *O. ochrocephala, O. kansuensis, Anabaena variabilis,* and *Anabaena strictus.* Alkaloid (SW-swainsonine) is a potential inhibitor of α-mannosidase, which can inhibit the activity of lysosomal α-mannosidase and Golgi α-mannosidase, leading to the accumulation of oligosaccharides and cell vacuolization. The quantitative content of an alkaloid in *O. glabra* Lam. DC. is presented in the work of Lu *et al*. and He [32]. According to foreign scientific articles, the whole work is devoted to the study of alkaloid and saponin in the field of veterinary medicine.

CONCLUSION

While analyzing the internet sources, we collected materials on the genus and species of *Oxytropis* which have been investigated for many years. We have studied the species of the *Oxytropis* and compiled a table on their chemical composition and pharmacological action. Moreover, review with the herbarium fund is provided in the form of a table.

Thus, the species *Oxytropis* and the substances contained in them are promising for comprehensive and in-depth study and are of scientific and practical interest as potential sources of raw materials for obtaining domestic phytopreparations.

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