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Types of Medicinal Plants of Kyrgyzstan with Sufficient Resource Potential

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ABSTRACT

The flora of Kyrgyzstan includes about 4000 species of higher plants, more than half of which have medicinal properties to some extent. The current status of 23 species of medicinal plants in Kyrgyzstan has been studied, and their resource potential can be successfully used as a reliable source of raw materials for the pharmaceutical industry. The resource potential of each of the studied species was determined using well-known geobotanical methods. As a result, the resource potential of each studied species within the territory of Kyrgyzstan for one growing season was clarified, and information about their botanical, phytogeographical, and economic characteristics as biological species was supplemented. Among the recorded species of medicinal plants of Kyrgyzstan, 9 species have herbs as a source of raw materials, 3 have rhizomes with roots, 3 have roots, and 5 have mature fruits. Such types of raw material sources as flower buds, immature fruits, seeds, milky plant juice, and flowers are represented only in 1 plant species each. The largest amount of raw materials of plant origin is found in *Rumex paulsenianus*, *Echium vulgare*, *Crataegus turkestanica*, and species (there are only 7

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of them) representing the genus *Rosa*. In the rest of the studied plants, this index is relatively lower than in the previous species.

Keywords: Genus; Species; Family; Medicinal Plant; Distribution; Raw Materials; Medicinal Properties; Resource Capabilities

1. Introduction

It is well known that in the pharmaceutical markets of Europe, the US, and other highly developed countries, the share of plant-based medicines is growing rapidly, reaching up to 50%. This is due to public awareness of the advantages of plant-based medicines, which are characterized by a wide range of biological activity and almost no side effects. In this regard, Kyrgyzstan occupies a special position, as its flora is one of the richest in the world in terms of area and contains about 4000 species of higher vascular plants. According to our observations and analysis of information on medicinal plants, about 60-70% of vascular plant species have excellent medicinal properties or are close relatives of recognized medicinal plant species. This is indirect evidence that they also have medicinal properties to one degree or another. A number of scientists believe that medicinal plants are an important natural resource of the country, used for medical and health needs[1]. Some of them are species endemic to Central Asia or a particular natural landscape. However, their potential is still not utilized by the economic entities of Kyrgyzstan on a large scale. This issue is related to the following problems:

– Scarcity or lack of data on medicinal species of specific territories, their resource potential and current status;
– Lack of a systematic approach to the use of the resource potential of wild medicinal plants in the national economy, taking into account environmental and economic requirements.

Due to the existing problems, part of the resource potential of medicinal plants in our country is not fully utilized by economic entities of Kyrgyzstan, which requires a timely solution to this issue. This issue is one of the urgent problems of our time, the optimal solution of which is important for improving the efficiency of the pharmaceutical industry[2,3]. As the data of pharmacological studies show, natural alkaloids have a higher quality of therapeutic effect and their duration of action is longer. In case of complete plant raw materials and sufficient stocks or successful plant culture, one or another alkaloid is undoubtedly more convenient and cost-effective to obtain from natural plant raw materials[4,5]. Some scientific works have noted that the northern slope of the Kyrgyz Ala-Too is characterized by species diversity of medicinal plants, which suggests the importance of such a scientific approach to clarify the species diversity of wild medicinal plants and their resource potential in other mountainous areas of Kyrgyzstan. As a result of the study of the biological resource potential of medicinal plants in the territory of the Eastern Priisykkuliya, the reserves of medicinal raw materials of common sawfly, common yarrow, and bitter wormwood were determined, which indicates the relevance of this topic for Kyrgyzstan[6–8]. In the work of Belyakov K.V. it was noted that species of the genera Inula and Leontopodium have a wide range of biological activity, where sesquiterpene lactones are a promising basis for the creation of new drugs. The drug “Allonton”, derived from biologically active substances of elecampane high, is widely known. The main biologically active substances of elecampane are sesquiterpene lactones—alantolactone, isoalantolactone and polysaccharide inulin[9]. Elecampane high is called Russian ginseng, because the active substances of its root have a multifaceted effect on the body. In diseases of the bronchopulmonary system, they promote expectoration of sputum, stimulate blood circulation and saturate the blood with oxygen, have an immunomodulatory effect, which helps combat viral and bacterial infections of the lungs. Especially relevant is the use of elecampane preparations for the treatment of pulmonary tuberculosis, mycoplasma respiratory infection and viral infections, such as COVID-19, herpes viruses, which can provoke serious lung changes, including pneumofibrosis and pneumosclerosis, formed within three months or more, and the resulting foci of fibrosis are not subject to involution[10]. A special work was carried out, where a complex geobotanical characterization of phytocenoses of the Northern Tien-Shan, in which medicinal plants occur, was given.

In assessing the current state of the dominant species of communities, in which, instead of other species of medicinal plants, large-leaved elecampane was considered [11]. There is a very informative work, where the results of comparative analysis of botanical and pharmacognostic study of large-leaved elecampane growing in Tajikistan in comparison with pharmacopoeial raw materials of elecampane high, as well as some physico-chemical and phytochemical parameters of the studied raw materials are presented [12]. Morphological and anatomical signs and diagnostic features of the above-ground part of the wild plant of British elecampane were studied in great detail according to the methods set forth in the State Pharmacopoeia XIV edition of the Russian Federation [13]. As a result of these studies, it was found that the flowers of British elecampane contain 0.19% britannin and 0.023% inuccinenolide C by dry weight [14].

In this regard, we have studied medicinal plant species of Kyrgyzstan, which to a greater or lesser extent are also distributed in the territory of the Alai Range, where we collected and analyzed materials on the current status of the studied species and clarified some features of their resource potential as an environmentally friendly raw material source for the needs of pharmaceutical activities of stakeholders [15–17]. There is information that elecampane has diuretic, diaphoretic, astringent, styptic, antiseptic, anti-inflammatory and sedative properties. It contains alkaloids, essential oil, inulin and carbohydrates. Preparations based on this plant are used for liver and throat diseases, as well as for warts, venereal diseases and acute respiratory diseases. A decoction of the herb of this plant is effective in angina pectoris and spasmophilia, while an infusion is effective in epilepsy. Leontopodium herb is rich in minerals: calcium, potassium and magnesium, as well as vitamins A, C and K. The plant contains tannins, flavonoids, chlorogenic and phenolic acids, which have pronounced antioxidant properties. The plant is not included in the State Pharmacopoeia of the Russian Federation, but folk medicine, especially Tibetan, practices edelweiss preparations internally for the treatment of respiratory and digestive diseases, and externally to combat long non-healing ulcers and burns. The chemical composition of these plants determines their properties: anti-inflammatory, anticonvulsant, antioxidant, expectorant, anti-stress, tonic. Leontopodium strengthens the immune system, which helps prevent colds, allows resistance to toxins, and slows down the natural aging of the body. Harmful and poisonous substances have not been found in the plant, and there are no contraindications to its use. Its preparations are not recommended in case of individual intolerance, and in cases of pregnancy and lactation, a doctor's consultation is required. Products enriched with Edelweiss extract have a protective and soothing effect, suitable for sensitive, aging skin, contribute to the inhibition of oxidative processes, give whiteness and rejuvenation to any skin, have a cleansing, stimulating, moisturizing, smoothing and refreshing effect, improve skin elasticity and tone, restore skin elasticity, contribute to the regeneration of skin cells, effectively soothe sensitive skin and have a healing effect on irritated skin.

Purpose of the work: to specify the list, distribution areas, and peculiarities of places of growing of wild medicinal species of plants, which have enough resource opportunities to meet the needs of the pharmaceutical industry of the national economy of the republic and neighboring countries in ecologically pure raw materials.

Objectives of the work:

- To identify, study and compile a list of economically valuable wild species of medicinal plants of Kyrgyzstan, through a detailed study of all possible literary information about a particular species, a detailed botanical description, collection of original photographs and herbarium specimens in the places of their natural habitat;
- To clarify the ranges of each species included in the list by organizing route expeditions to natural areas of Kyrgyzstan, collecting and analyzing all available literary and other information about them.

2. Materials and Methods

Materials for this paper were collected: 1. During the organization of educational and field practices on botany and pharmacognosy with students of the Faculty of Biology and Medical College of Osh State University from 2014 to 2023, the routes of which covered natural landscapes, reserves, and natural parks of the south of the country; 2. Within the framework of the following projects, which had grant support from donor organizations, where there were places of organization of route expeditions to natural areas of Kyrgyzstan: a) Forestry Development Fund of Osh and Batkens regions -

"Study of the species composition of higher plants common in the territory of the Kulun-Ata State Nature Reserve"; b) Ministry of Education and Science of the Kyrgyz Republic - "Rational use of underutilized wild useful flora species of Kyrgyzstan in pharmaceutical, food and perfume industries" - 2018; "Potential opportunities of wild economically valuable and ornamental plant species inhabiting unique and attractive natural areas for tourism development in Kyrgyzstan" - 2020; c) Helvetas in the Kyrgyz Republic - "Study of flora and fauna of Alai and Chon-Alay districts" - 2019; d) Osh State University - "Utilization of resource opportunities of wild medicinal plant species of Kyrgyzstan, by specifying their habitats and biological features" – 2021-2023.

Botanical description of plant species, their herbarization, obtaining original photographs of the whole plant or its parts, and clarification of the resource potential of each plant species as a source of raw materials for the pharmaceutical industry were carried out using well-known methods [18–21]. When determining the yield of medicinal plants, the type of raw material obtained from a particular plant was taken into account. Therefore, regardless of the fact that research expeditions were organized according to the seasons of the year, taking into account the altitudinal distribution of plants, the yield of a particular plant species was recorded at one stage of the expedition. As for the yield indicators for each species taken into account, they were determined only for the year when the territory where the plant species grew was covered by the expedition. There was no need to compare their yields with literature data, since the yield of many medicinal plant species was studied for the first time.

When conducting resource surveys, the area of a thicket of a particular species was determined by equating its shape to a geometric figure and measuring the parameters (length, width, diameter, etc.) necessary to calculate the area of this figure. The area was measured by commonly used methods. Plants that are unevenly distributed in the thicket, forming separate patches (clumps), were first determined by determining the area of the whole territory where this species occurs, and then the percentage of the area occupied by this species. This procedure was carried out by laying a series of parallel and perpendicular route tracks in the surveyed area, divided into equal-length segments. Within each such segment, the portion traveled by a spot occupied by the species under study was counted.

Yield (raw material stocking density) was determined using three methods: the method of using counting plots, the method of model specimens and on the basis of determining projective cover. The choice of the method is primarily related to the peculiarities of the life form and habitus of the plants and the part used as raw material. For small herbaceous plants and shrubs in which the above-ground organs are used as raw material, it is more rational to determine the yield on survey plots. This method is the most accurate, as there are no additional recalculations that reduce the accuracy of the study. However, this method is too labor-intensive when estimating the yield of underground organs or when working with large plants, which require the establishment of survey plots of large size. In these cases, the method of model specimens is preferred. For low-growing herbaceous and shrubby plants, especially when they form dense turfgrasses, it is recommended that yield estimates be based on projective cover.

Determination of yield at the survey plots. The size of the plot was set depending on the size of adult specimens of the species under study. The optimum size of the plot was considered to be the size of the plot with at least five adult specimens of plants. The survey plots were laid evenly at a certain distance from each other in such a way as to cover, if possible, the entire stand or thicket. A series of route passes crossing the thicket in different directions was marked, and plots were laid along these passes after a certain, predetermined number of meters (3, 5, 10, 20, etc.). Plots were laid irrespective of the presence or absence of specimens of the species under study at a given location. Only if the array consists of individual patches occupying a specified percentage of the area, the survey plots are located only within these patches (clumps). After laying out the survey plots, all raw phytomass was collected at each of them in accordance with the requirements of normative and technical documentation (NTD) for a particular type of raw material and recommendations for the collection and drying of this species (**Figure 1**). Raw materials were immediately weighed with an accuracy of ±5% (collected from each site separately). In determining the value of the stock, the yield was determined and multiplied by the value of the area of the thicket.

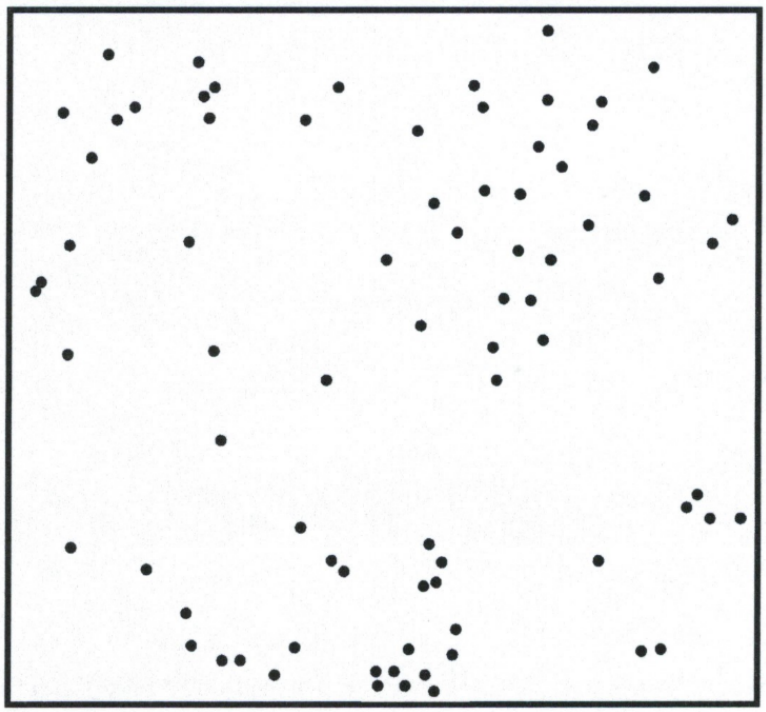

Figure 1. Distribution pattern of the species on the surveyed site.

Determination of yield from model specimens. By the term model specimen is meant an average commercial specimen (or sometimes a shoot) of a medicinal plant, determined on a particular commercial thicket of the massif. When estimating yield by this method, two indicators are set: the mass of raw material obtained from the model specimen and the number of marketable specimens (shoots) per unit area. Individual specimens are used when the plants are relatively small and the "boundaries" of the specimens are easy to establish (**Figure 2**). In cases where collecting raw material from a whole specimen is laborious (trees, large shrubs) or its boundaries are difficult to determine, it is preferable to use a shoot as a counting unit. Counting the number of specimens (shoots) is carried out on counting plots of 0.25 to 10 m^2, the principles of which are described in the previous section. However, in this case it is more convenient to count the number of marketable specimens (shoots) on narrow (1–2 m wide) and stretched along the route, the so-called transects. In order to estimate yields with an accuracy of up to 15% using this method, the number of specimens and the size of their raw phytomass should be determined with an accuracy of up to 10%. Marketable specimens (or shoots) for determining the mass of the model specimen are selected at the survey sites. The most objective is systematic sampling, where every second, third, fifth or tenth specimen (shoot) encountered along the route is taken for determination. Each specimen is weighed for its raw material part and then the average value of this index is calculated (M ± m). The number of specimens in the sample, representative of the mass of the model plant, is determined by the same formula as the number of sampling sites. Obviously, the sample size depends on the degree of variation in the mass of raw material in individual specimens. On average, 40–60 specimens are sufficient for determining the weight of underground organs or inflorescences. Above-ground parts vary more in mass, so the number of "selected" specimens (shoots) is usually close to 100 or even more. Yield is calculated by multiplying the average number of specimens per unit area by the average weight of the model specimen.

Determination of yield by projective coverage. Projective coverage means the area of projections of the above-ground parts of plants. Determination of yield by the projective cover method is convenient when working with low or stalked plants such as cowberry, bearberry or thyme. To determine yields using this method, two values are set: the average projective cover of the species within the field thicket and the yield of raw material from 1 % of projective cover (the so-called price of 1 % projective cover). The average

projective cover is determined on the basis of measurements of projective cover in a series of survey plots. The required number of survey plots is determined in the same way as described for the counting plot method. Measurements are made in different ways: by eye, by Ramensky grid or by square-grid. The first two methods can be recommended only to experienced researchers. The use of a grid square gives satisfactory results even with relatively little experience in resource studies. To determine the price of 1% of projective cover, raw material is cut from 1 dm^2 at each survey site. Then the phytomass of the raw material from each "cut" dm^2 is weighed (this corresponds to 1% of the projective cover) and the average statistical value of the price of 1% cover is calculated. Yield is calculated as the product of the average projective cover by the price of 1% using the same formulae as for model specimens.

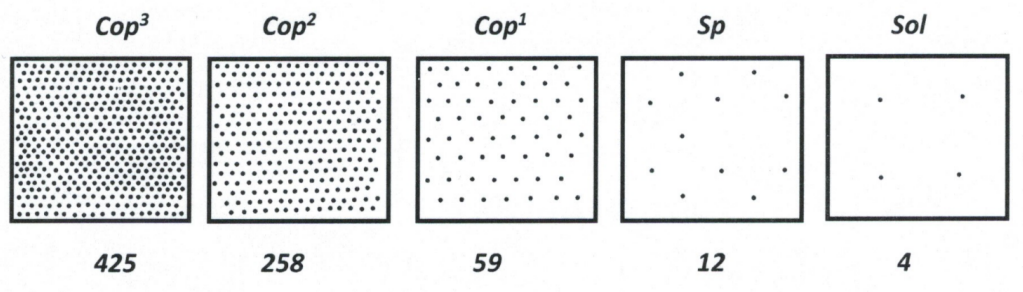

Figure 2. To account for the number of specimens of a medicinal plant, the yield of which was determined by the method of model specimens in the registered territory.

Calculation of stocking rates on specific thickets. The methods of determining the yield and area of specific thickets or arrays allow us to proceed to the determination of the stock of raw materials. Resource scientists distinguish two types of stocks, biological and exploitable. Biological stock is the amount of raw phytomass formed by all (marketable and non-marketable) specimens of a given species in any area, both suitable and unsuitable for harvesting. Exploitation (commercial) stock is the amount of raw phytomass formed by marketable specimens in areas suitable for commercial harvesting. In those cases, when the yield is determined directly on the accounting sites, laid in a particular thicket, the stock of medicinal plant raw material in this thicket is calculated as the product of the average yield and the total area of the thicket. When determining the value of the stock using the methods of model specimens and projective cover, the yield in a given thicket is first calculated as described in the relevant sections, and then the obtained value is multiplied by the value of the area of the thicket. The biological stock is calculated using the upper yield limit (M + 2m), but this value is of little practical value. The value of the exploitation stock is calculated using the lower limit (M − 2m).

Calculation of annual harvest volumes. The exploitable stock of raw materials shows how much raw material can be harvested during a one-time operation of the thicket. However, annual harvesting in the same thicket is only allowed for medicinal plants that bear fruit. In this case, the total value of the exploitation stock in all stands is equal to the possible volume of annual harvesting. In other cases, when calculating the possible annual harvest, it is necessary to know how many years after harvesting the thicket restores the original stock of raw materials. It is considered that for inflorescences and aboveground organs of annual and perennial plants, once every 4–6 years; for underground organs of most plants - not more often than once in 15–20 years. In northern areas and thickets located in the worst habitat conditions, the maximum duration of the regeneration period should be taken. The volume of possible annual harvesting of raw materials is calculated as a quotient of the operational stock of raw materials divided by the harvesting turnover, including the year of harvesting and the duration of the regeneration period ("rest") of the thicket. Thus, if the operational stock of St. John's wort in the harvesting array is 200 kg, and it recovers in these geographical conditions in 4 years, then within this array, possible annual harvesting should not exceed 200/(4 + 1) = 40 kg. When determining harvesting locations, it is assumed that each thicket in the array should be exploited not more often than once in 5 years.

Based on the analysis of available stocks and the volume of harvesting, the necessary recommendations are made

on the possibilities of their increase or the need to reduce them. In addition, proposals are made to establish sanctuaries to protect rare medicinal plants or highly productive commercial thickets and arrays [18–21].

3. Results

Based on the analysis of the collected materials and collected information from various literary sources, we have identified 23 species of higher plants of the flora of Kyrgyzstan, which can be used as a natural, environmentally friendly source of raw materials to meet the needs of the pharmaceutical industry of the national economy of the Kyrgyz Republic and neighboring countries (**Table 1**).

Rumex paulsenianus (146,350 kg of raw material in the form of rhizome with roots for one economic year) has the largest amount of raw material of plant origin within the accounted territory of the south of the Kyrgyz Republic according to the indicators of annual productivity. Productivity of *Gentiana algida* is established within 810 kg of raw material per year in the form of dried herb, which is the lowest indicator among the analyzed species. Other medicinal plant species occupy an intermediate position between these species according to this indicator. However, *Echium vulgare* (62,380 kg of raw material per year in the form of dried herb), *Crataegus turkestanica* (73,460 kg of raw material in the form of mature fruits) and species (seven in total) representing the genus *Rosa* (123,500 kg of raw material in the form of mature fruits) are also distinguished among the studied species with the highest productivity (**Figure 3**).

Table 1. List of medicinal plants of Kyrgyzstan, the resource potential of which can be successfully used as a reliable environmentally friendly source of raw materials for the pharmaceutical industry.

№	Species Name	Character Habitat	Type of Raw Materials Obtained from the Plant, Medicinal Property	Resource Capabilities, kg
1	*Ephedra equisetina* Bunge: AK; w.	On stony and rubbly slopes of mountains in their middle belt, on gravels.	Grass, cones. They mainly contain the alkaloid ephedrine, pseudoephedrine and serve as the main raw material for its extraction.	Within 66500 kg per year of raw materials in the form of herbs, cones
2	*Rumex paulsenianus* Rech. f.: NK, FRK; se.	On high-mountain meadows, often forms thickets on stands.	Rhizome with roots. Contains tannides. Used in gynecological practice, in hyperpolymenorrhea, colitis, inflammatory diseases of the vagina.	146350 kg of raw material in the form of rhizome with roots
3	*Polygonum coriarium* Grig. (*P. bucharicum* Grig.: WT, FRK, IT; se.	In the forest-meadow belt of mountains on clay and rubbly slopes.	Roots. Tannin, used to treat bloody diarrhea.	22500 kg of raw material per year in the form of rhizomes and roots
4	*Capparis herbacea* Willd. (*C. spinosa* auct. non L.): NK, IB, WT, FRK; w.	On deposits on gray soils, on clayey rubbly solonetz soils of the plain, on slopes of lower mountain belts	Flower buds, immature fruits, seeds. They are used as food with a variety of biologically active substances. Oil is extracted from the seeds, which contains about 18% protein and 30% crude fat.	13350 kg of raw materials per year in the form of flower buds, immature fruits and seeds
5	*Crataegus pontica* C.Koch: WT, FRK; w.	On gravelly, dry slopes.	Fruit. Appointed in functional disorders of cardiac activity, atrial fibrillation, general atherosclerosis and menopausal neurosis	12560 kg of raw material in the form of mature fruit.
6	*Crataegus turkestanica* Pojark.: NK ,WT, FRK, A; w.	In the undergrowth of walnut forests, in riparian forests and among shrub thickets	Fruits, flowers. Medicinal, food, honey plant.	73460 kg of raw material in the form of mature fruit
7	Genus *Rosa (Total 7 species)*	In the forest glades, among the bushes.	Fruits. They contain vitamin C.	123500 kg of raw material in the form of mature fruit
8	*Amygdalus bucharica* Korsh.: FRK; w.	On stony-rubble slopes, scree slopes in juniper forests at an altitude of 850-2500 m in belts of ephemeral and tree and shrub vegetation	Seeds. They contain fatty oil, emulsin enzyme, protein substances, sugars, vitamin B2, amygdalin glycoside.	13700 kg of raw material in the form of mature fruit (pips)

Table 1. *Cont.*

№	Species Name	Character Habitat	Type of Raw Materials Obtained from the Plant, Medicinal Property	Resource Capabilities, kg
9	*Glycyrrhiza glabra* L.: NK, IB, WT, FRK, IT; w.	Along river banks, in steppe and semi-steppe areas, as well as in mountainous areas, if it can reach groundwater by its roots	Roots, rhizomes. Used in diseases of the upper respiratory tract as an expectorant, emollient and anti-inflammatory agent.	14430 kg of raw material in the form of rhizome with roots
10	*Hippophae turkestanica* (Rousi) Tzvelev (*H. rhamnoides* auct. non L.): AK; w.	Along banks, gravels, in tugai, less often slopes of gorges, rocks and precipices. Climbs up to 2000 m in the mountains.	Fruit. The oil has wound-healing and analgesic properties, it is used to treat scaly rash, Darier's disease, burns, frostbite, eczema, as a vitamin remedy for hypo- and avitaminosis	18870 kg of raw material per year in the form of mature berries
11	*Carum carvi* L.: AK; w.	In meadows, in sparse coniferous and mixed forests and along edges; near roads, dwellings, weedy in crops; in the mountains it reaches up to 4000 m	Fruit. In the pharmaceutical industry it is used for the preparation of galenic preparations against flatulence. It is prescribed for intestinal dysfunctions, colitis and enteritis.	1640 kg of raw material per year in the form of mature fruit
12	*Ferula foetida* (Bunge) Regel: FRK; w.	On fine-grained and stony slopes up to 2500 m into the mountains	Resin from roots, stems. Contains gum, essential oil, resin. Prescribed as a tincture against convulsions.	33670 kg of raw material per year in the form of resin
13	*Gentiana algida* Pall.: NK, IB, CT, WT, IT, A; w.	On cobresia heaths, alpine belt grasslands and glacial cirques	Herb. Infusion is used in acute bronchitis, pulmonary tuberculosis, sore throat, laryngitis, croup pneumonia. The tincture has anti-votrichomonad activity.	810 kg of raw material per year in the form of dried herbs.
14	*Echium vulgare* L.: AK; w.	On wastelands, fallow lands, along roads, on stony bare slopes, especially often in the steppe belt	Herb. It contains saponins and alkaloids: consilicin, choline and cynoglossine. It promotes expectoration of sputum and has features to reduce cramps.	62380 kg of raw materials per year in the form of dried herbs.
15	*Salvia sclarea* L.: NK, WT, FRK; w.	It grows on stony, clay, loess, fine-gravel, fine-gravel slopes, on sands, on arable land, in gardens as a weed	Herb. The oil is used to treat burns of varying degrees of severity, as well as long non-healing wounds. It increases immunity, prevents insomnia, relieves anxiety and tension	12980 kg of raw material per year in the form of dried herbs
16	*Perovskia abrotanoides* Kar.: NK, IB, WT, FRK, IT; w.	On dry gravels, stony and rubbly slopes up to 2000 m above sea level	Herb. It has analgesic, sedative, antiseptic, cooling effect and has high antioxidant and antimicrobial activity.	10730 kg of raw material per year in the form of dried herbs
17	*Ziziphora clinopodioides* Lam. (*Z. brevicalyx* auct. non Juz.): NK, IB, WT, FRK, IT, A; w.	Grows on rocky and rocky riverbanks, stony and rubbly hillsides and mountains.	Herb. It has sedative, styptic, antispasmodic, lowering body temperature, diuretic, antitumor, antibacterial, anthelmintic, anthelmintic, general supportive effect. Treats colds, flu, relieves headache, relieves cough.	24370 kg of raw material per year in the form of dried herbs
18	*Origanum vulgare* L.: NK, IB, WT, FRK, IT; w.	It grows in glades, edges, among shrubs, on dry open grassy places, on hillsides	Herb. It is used in colds and other respiratory diseases as an anti-inflammatory and expectorant agent	12850 kg of raw material per year in the form of dried herbs
19	*Patrinia intermedia* (Hornem.) Roem. et Schult.: NK, IB, CT, WT, FRK, IT; w.	On dry mountain slopes and steppes of foothills from 800 to 2500 m above sea level	Roots. They contain saponins, tannins, essential oils and nitrogen-containing bases. Used as a sedative, the effect of which is 1.5-2 times greater than that of valerian	24360 kg of raw material per year in the form of dried root

Table 1. *Cont.*

№	Species Name	Character Habitat	Type of Raw Materials Obtained from the Plant, Medicinal Property	Resource Capabilities, kg
20	*Leontopodium ochroleucum* Beauverd.: AK; w.	On alpine meadows, cobresia, clay and stony slopes, on dry banks of rivers in the upper belt of mountains, among junipers	Herb. Infusion of the herb has choleretic effect. On the Tien Shan, herb decoction is used for heart diseases, stomach cramps.	13450 kg of raw material per year in the form of dried herbs
21	*Inula macrophylla* Kar. et Kir. (*I. grandis* Schrenk): NK, IB, WT, FRK; se	On steppe slopes, stony screes of foothills and mountains, among shrubs, not rising above 2500 m above sea level.	Rhizome. It is used as a tonic for stomach and intestinal ulcers. The roots contain inulin, essential oils and a large amount of resins.	23400 kg of raw material per year in the form of rhizomes.
22	*Artemisia dracunculus* L.: AK; w.	On pastures of the middle belt of mountains, often in entire thickets; in valleys - near ditches, on wastelands	The herb. It is anthelmintic. It contains 2 types of essential oil: methylchavicol, sabinin.	117360 kg of raw materials per year in the form of dried herbs
23	*Taraxacum officinale* Wigg.: NK, IB, IT, FRK, WT; w.	On meadows, forest glades, in gardens and parks, near roads, in settlements up to 2500 m above sea level.	Roots. They stimulate the appetite and improve the activity of the digestive organs.	21540 kg of raw material per year in the form of dried roots

Note: Biogeographic zoning of Kyrgyzstan:
NK – Northern Kyrgyzstan (Chui Valley, Chon-Kemin River valley with adjacent northern slopes of the Kyrgyz Range and Kungai Ala-Too);
IB – Issyk-Kul Basin (including northern slopes of the Terskey Ala-Too, southern slopes of the Kungai Ala-Too and the Tyup River valley);
CT – Central Tien-Shan (Sary-Jaz river basin);
WT – Western Tien-Shan (including Toktogul basin, Talas and Chatkal valleys);
FRK – Fergana regions of Kyrgyzstan (including southern slopes of Chatkal and Fergana ranges and northern slopes of Alai and Turkestan ranges);
IT – Inner Tien Shan (the area is bounded in the north by the Kyrgyz Range, in the southwest by the Fergana Range and in the southeast by the Kokshaal-Too Range);
A – Alai valley (including southern slopes of the Alai and northern slopes of the Zaalai ranges);
AK – All Kyrgyzstan, the species occurs in all areas accepted in the "Cadastre..."
Scheme of indication of general distribution of species:
e – endemic species (occurs only within Kyrgyzstan);
se – sub-endemic species (the range of the species covers Kyrgyzstan, territories of other Central Asian republics and neighboring areas of China);
w – widespread species (the range of the species covers significant areas of the Palearctic or the species is even more widespread).

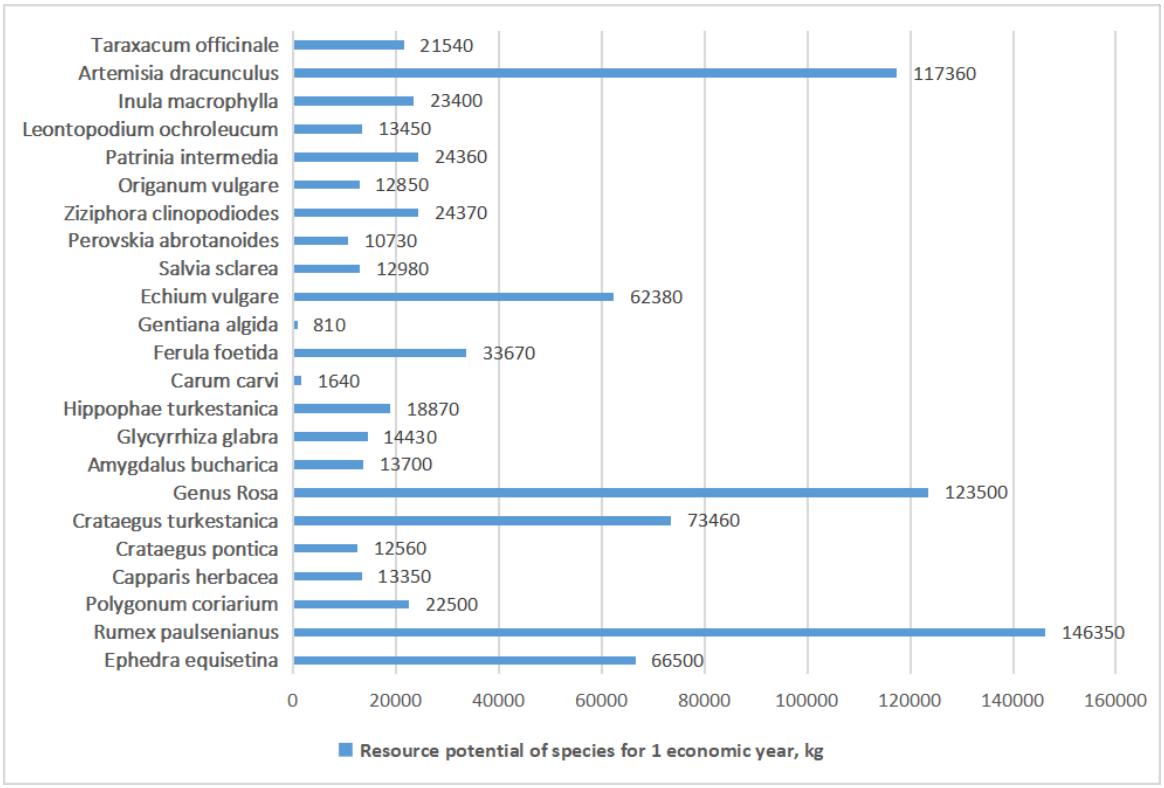

Figure 3. The productivity of certain types of medicinal plants in Kyrgyzstan over one growing season, which can be used as a source of raw materials for the pharmaceutical industry.

4. Discussion

4.1. Systematic Affiliation

Of the species we studied, 1 species represents the department of gymnosperms, i.e., is a representative of the class Gnetopsida, the remaining 22 species are representatives of only the class Magnoliopsida of the department of covered plants. These species represent 11 families, 22 genera of the divisions of holodwarf and covered plants. The largest number of genera belong to Compósitae, Labiátae (4 species each), and Rosaceae, Umbellíferae (2 species each), the remaining 9 families are represented by only one genus each. This group includes 2 species of the genus *Crataegu*s and 7 species of the genus *Rosa*. On the territory of Kyrgyzstan, there are about 26 species of the genus *Rosa*, which to a greater or lesser extent have medicinal properties, especially they contain biologically active substances in the form of vitamin C. However, the resource potential of these species as a source of medicinal raw materials varies. According to our study, species such as *Rosa alberti* Regel, *R. beggeriana* Schrenk, *R. canina* L., *R. fedtschenkoana* Regel, *R. kokanica* (Regel) Juz, *R. maracandica* Bunge, *R. platyacantha* Schrenk are included in the species of medicinal plants of Kyrgyzstan, the resource potential of which is sufficient for their use as an environmentally friendly source of medicinal raw materials.

4.2. Distribution Areas by Phytogeographical Regions of Kyrgyzstan

Ephedra equisetina Bunge, *Hippophae turkestanica* (Rousi) Tzvelev, *Carum carvi* L., *Echium vulgare* L., *Leontopodium ochroleucum* Beauverd. and *Artemisia dracunculus* L. are found in all phytogeographical regions of Kyrgyzstan. Among the studied species of medicinal plants *Capparis herbacea* Willd., *Crataegus pontica* C.Koch, *Crataegus turkestanica* Pojark., *Rosa alberti* Regel, *R. beggeriana* Schrenk, *R. canina* L., *R. maracandica* Bunge, *Amygdalus bucharica* Korsh, *Glycyrrhiza glabra* L., *Ferula foetida* (Bunge) Regel, *Gentiana algida* Pall., *Salvia sclarea* L., *Perovskia abrotanoides* Kar., *Ziziphora clinopodioides* Lam., *Origanum vulgare* L., *Patrinia intermedia* (Hornem.) Roem. et Schult., *Artemisia dracunculus* L., *Taraxacum officinale* Wigg. are characterized as widespread in Kyrgyzstan, as for *Rumex paulsenianus* Rech. f., *Polygonum coriarium* Grig. f., *Inula macrophylla* Kar. et Kir., *Rosa fedtschenkoana* Regel., *R. kokanica* (Regel) Juz. *R. platyacantha* Schrenk., they have the status of sub-endemics of adjacent territories of neighboring countries [22–26].

4.3. Habitat Characteristics

Ephedra equisetina Bunge, *Polygonum coriarium* Grig., *Crataegus pontica* C.Koch., *C. turkestanica* Pojark., *Rosa alberti* Regel, *R. beggeriana* Schrenk, *R. canina* L, *R. fedtschenkoana* Regel, *R. maracandica* Bunge, *Amygdalus bucharica* Korsh, *Carum carvi* L., *Echium vulgare* L., *Ziziphora clinopodioides* Lam., *Patrinia intermedia* (Hornem.) Roem. et Schult. inhabit the middle woody-shrub belt of mountains, mountain slopes and mountain meadows. Various phytocenoses of the foothill zone are inhabited by *Capparis herbacea* Willd, *Rosa kokanica* (Regel) Juz., *R. platyacantha* Schrenk, *Ferula foetida* (Bunge) Regel., *Salvia sclarea* L., *Perovskia abrotanoides* Kar., *Inula macrophylla* Kar. et Kir., *Taraxacum officinale* Wigg. As for the territory of the subalpine belt, there are *Rumex paulsenianus* Rech. f., *Origanum vulgare* L., *Artemisia dracunculus* L. included in this list. In phytocenoses, which are concentrated in the alpine belt – *Gentiana algida* Pall., *Leontopodium ochroleucum* Beauverd., and along river shorelines and gravels *Glycyrrhiza glabra* L., *Hippophae turkestanica* (Rousi) Tzvelev.

4.4. Types of Raw Materials Obtained from Medicinal Plants

Of the 23 identified species of medicinal plants in Kyrgyzstan, the resource potential of which can be successfully used as a reliable, environmentally-friendly source of raw materials for the pharmaceutical industry, 9 species of raw materials of plant origin for the manufacture of medicines on an industrial basis are of interest. Also, of these 23 species of medicinal plants, the raw material source in 9 species—*Ephedra equisetina* Bunge, *Gentiana algida* Pall., *Echium vulgare* L., *Salvia sclarea* L., *Perovskia abrotanoides* Kar, *Ziziphora clinopodioides* Lam., *Origanum vulgare* L., *Leontopodium ochroleucum* Beauverd., *Artemisia dracunculus* L.—is herb; in 3 species—*Rumex paulsenianus* Rech. f., *Glycyrrhiza glabra* L., *Inula macrophylla* Kar. et Kir.—it is rhi-

zome with roots; in 3 species—*Polygonum coriarium* Grig., *Patrinia intermedia* (Hornem.) Roem. et Schult., *Taraxacum officinale* Wigg.—it is roots; in 5 species—*Crataegus pontica* C.Koch., *C. turkestanica* Pojark., species of the genus *Rosa*, *Hippophae turkestanica* (Rousi) Tzvelev, *Carum carvi* L.—it is mature fruits. Such types of raw material source of plant origin as flower buds (*Capparis herbacea* Willd), immature fruits, seeds (Amygdalus bucharica Korsh.), resin from roots, stems, and flowers (*Ferula foetida* (Bunge) Regel), are represented only in 1 plant species each.

4.5. Resource Capacity for One Growing Season

At the present stage, medicinal plants such as *Artemisia dracunculus, Echium vulgare, Ferula foetida,* species of the genus *Rosa, Crataegus turkestanica, Rumex paulsenianus,* and *Ephedra equisetina* have sufficient resource potential as environmentally friendly natural sources of plant-based medicinal raw materials that can be directly used by pharmaceutical companies in Kyrgyzstan. As for the species *Taraxacum officinale, Inula macrophylla, Patrinia intermedia, Ziziphora clinopodioides, Hippophae turkestanica,* they also have sufficient raw material sources that can be successfully used, taking into account environmental requirements when collecting raw materials. The remaining species *(Polygonum coriarium, Glycyrrhiza glabra, Amygdalus bucharica, Capparis herbacea, Leontopodium ochroleucum, Salvia sclarea, Origanum vulgare, Crataegus pontica, Perovskia abrotanoides, Carum carvi, and Gentiana algida),* regardless of their productivity per growing season, are characterized as a reliable source of environmentally friendly medicinal raw materials for the needs of pharmaceutical companies due to the high concentration of biologically active substances contained in the raw materials obtained from these medicinal plants. For example, the resource potential of *Carum carvi* per growing season is insignificant (within 1640 kg of ripe fruits), however, it can be used to obtain a sufficient amount of medicinal products that have an effective effect on the human body.

5. Conclusions

It has been established that 23 species of vascular plants in the Kyrgyzstan flora are recommended for use as a natural, environmentally-friendly source of raw materials to meet the needs of the pharmaceutical industry of the Kyrgyz Republic and neighboring countries.

Ephedra equisetina, Hippophae turkestanica, Carum carvi, Echium vulgare, Leontopodium ochroleucum, and *Artemisia dracunculus* are found in all phytogeographical regions of Kyrgyzstan, while the rest are found in most of them. Of these, most (15) are characterized as widespread species, whose ranges cover significant areas of the Palearctic, or species that are even more widespread, which is the case for eight species that have the status of subendemic species in the neighboring territories of neighboring countries.

The following data are available on the vertical zonation of mountainous areas and types of phytocenoses from bottom to top, where the recorded species of medicinal plants of Kyrgyzstan are found:

- in various phytocenoses of the foothill zone – 11 species;
- in the middle tree-shrub zone of mountains, mountain slopes, and mountain meadows – 20 species;
- in the subalpine zone – 5 species;
- in the alpine zone – 2 species;
- along the coastlines of mountain rivers and pebble beaches – 2 species.

The sources of raw materials for the recorded species are: grass – 9 species; rhizomes with roots – 3; roots – 3; ripe fruits – 5; flower buds – 1; unripe fruits – 1; seeds – 1; resin – 1; flowers – 1.

The largest amount of raw materials is possessed by *Rumex paulsenianus* (146,350 kg), representatives of the genus *Rosa* (123,500 kg), and *Artemisia dracunculus* (117,360 kg); *Crataegus turkestanica, Echium vulgare, Ephedra equisetina, Ferula foetida, Ziziphora clinopodioides, Patrinia intermedia, Inula macrophylla, Taraxacum officinale*, and *Hippophae turkestanica*; for the remaining medicinal plant species recorded in Kyrgyzstan, this indicator is significantly lower than for the above-mentioned species.

Author Contributions

All authors made significant contributions to this study. O.K. developed the study concept;O.K. developed the methodology; O.M. and Z.E. contributed to data collection

and resources; A.D. supervised the data; G.M. and M.S. prepared the initial draft; O.M. and O.K. reviewed and edited the manuscript; O.K. supervised the study. All authors have read and approved the final manuscript.

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Data Availability Statement

All data supporting the reported results are provided within the manuscript. Additional data can be made available upon reasonable request.

Conflict of Interest

All the authors declare that there is no conflict of interest in relation to the research, authorship, and publication of this study.

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