Introduction. Low toxicity with a sufficiently high efficiency, a wide range of therapeutic action, a minimum of side effects, as well as a relatively low cost allow medicinal plant materials (MPM) and preparations based on them to occupy a stable position in the pharmaceutical market. Currently, a significant proportion of consumers of herbal medicines is occupied by the perfumery, cosmetics and food industries. This contributes to the increasing demand for herbal medicines [1].

The growth of industry leads to an increase in the anthropogenic load, which negatively affects the state of plant objects. Test sites, which are the sources of radiation contamination of the territory of our country, have a negative impact on the soil cover. Enterprises of the oil and gas complex and non-ferrous metallurgy of the republic are among the leaders in soil pollution with various chemical compounds, including heavy metals. A significant role in the land pollution of cities and other settlements belongs to motor transport, the number of which has increased significantly in recent years. The use of pesticides during various types of agricultural treatment of seeds and plants can also lead to soil contamination and accumulate in medicinal herbal remedies [2-4].

The above anthropogenic factors necessitate quality control of medicinal products, taking into account traditional pharmacopeial indicators.

The guiding principle of quality assessment in relation to the safety of medicinal plant materials is the regulation of the content of residual contaminants, including heavy metals, arsenic, radionuclides, pesticides and the number of microorganisms.

In order to systematically ensure the appropriate quality of medicinal plants and the raw materials and substances obtained from them, proper principles for the cultiva-

Resume. This article presents the results of a safety assessment of the plant material Crocus alatavicus. The following contents were determined: heavy metals and arsenic, radionuclides (strontium-90 and cesium-137), the residual amount of pesticides, the indicator is microbiological purity.

Key words: Crocus alatavicus, the safety of plant materials, radionuclides, heavy metals, pesticides, microbiological purity, medicinal plant materials.

SAFETY ASSESSMENT OF PLANT RAW MATERIALS CROCUS ALATAVICUS

Resume. В данной статье приведены результаты оценки безопасности растительного сырья Crocus alatavicus. Определены содержания: тяжелые металлы и мышьяк, радионуклиды (стронций-90 и цезий-137), остаточное количество пестицидов, показатель – микробиологическая чистота.

Ключевые слова: Crocus alatavicus, безопасность растительного сырья, радионуклиды, тяжелые металлы, пестициды, микробиологическая чистота, лекарственное растительное сырье.
tion and preparation of medicinal plants have been introduced. In the case of herbal preparations, the production and primary processing of raw materials directly affect the content and quality of biologically active substances (BAS). Due to the complexity of biologically active substances and the limited possibilities of analytical methods for their complete characterization, the provision of the required level of quality is required already at the stage of collection, cultivation, harvesting and primary processing of medicinal plant materials. Therefore, to solve all these problems, the World Health Organization developed in 2003 guidelines on good principles (methods) for the cultivation and harvesting of medicinal plants (GACP). We have developed a method for cultivating Crocus alatavicus from seeds in accordance with the principles of GACP [5, 6].

**The purpose of this work** is to evaluate the safety parameters of Crocus alatavicus Regel & Semen of the Iridaceae family.

**Materials and methods.** Materials and methods. The object of the study is the dried whole raw materials of Crocus alatavicus, collected during the flowering period. The analyses were carried out according to pharmacopoeia methods.

**Experimental part** Heavy metals and arsenic. Determination of heavy metals and arsenic was carried out in accordance with the State Pharmacopoeia of the Republic of Kazakhstan (SPh RK I), vol.1, 2.4.8 and 2.4.2 – "Heavy metals" and "Arsenic" in medicinal plant raw materials and medicinal plant preparations by atomic absorption spectrometry (SPh RK I, vol.1, 2.2.23) [7].

Pesticides. According to the general monograph "Medic-

### Table 1 - Determination of compliance of heavy metals and arsenic in raw materials with acceptable standards

<table>
<thead>
<tr>
<th>Identification of the sample</th>
<th>The name of the determined indicator</th>
<th>LOQ, mcg/kg</th>
<th>Фактическое значение, mcg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crocus alatavicus Regel &amp; Semen</td>
<td>Cadmium</td>
<td>1,0</td>
<td>not detected</td>
</tr>
<tr>
<td></td>
<td>Lead</td>
<td>6,0</td>
<td>0,1164</td>
</tr>
<tr>
<td></td>
<td>Mercury</td>
<td>0,1</td>
<td>not detected</td>
</tr>
<tr>
<td></td>
<td>Arsenic</td>
<td>0,5</td>
<td>not detected</td>
</tr>
</tbody>
</table>

### Table 2 - Determination of the compliance of the content of residual pesticides in raw materials with acceptable standards

<table>
<thead>
<tr>
<th>Identification of the sample</th>
<th>Name of the indicator to be determined</th>
<th>Pesticide residue limit, mg/kg</th>
<th>Actual value, µg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crocus alatavicus Regel &amp; Semen</td>
<td>α - HCCH</td>
<td>not more than 0.1 (SPh RF)</td>
<td>not detected</td>
</tr>
<tr>
<td></td>
<td>β - HCCH</td>
<td>total not more than 0.3 (EPh)</td>
<td>not detected</td>
</tr>
<tr>
<td></td>
<td>γ - HCCH</td>
<td>not more than 0.1 (EPh)</td>
<td>0,00215</td>
</tr>
<tr>
<td></td>
<td>DDE, r, r.</td>
<td>total not more than 0.1 (SPh RF)</td>
<td>0,00262</td>
</tr>
<tr>
<td></td>
<td>DDT, r, r.</td>
<td>total not more than 0.6 (EPh)</td>
<td>0,00284</td>
</tr>
<tr>
<td></td>
<td>Aldrin</td>
<td>not allowed (SPh RF)</td>
<td>not detected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>not more than 0.05 (EPh)</td>
<td>not detected</td>
</tr>
</tbody>
</table>

### Table 3 - Contents of strontium-90 and cesium-137 in plant raw material C.alatavicus

<table>
<thead>
<tr>
<th>Names of indicators</th>
<th>ND for test methods</th>
<th>ND requirements</th>
<th>Actual results (Bq/kg)</th>
<th>Temperature °C, humidity</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content of strontium-90, Bq/kg</td>
<td>MVI № KZ 07.00.00303-2019</td>
<td>Up to 200</td>
<td>0,92</td>
<td>20,8°C 72%</td>
<td>Up ± 3,25</td>
</tr>
<tr>
<td>Cesium-137 content, Bq/kg</td>
<td>MVI № KZ 07.00.00304-2019</td>
<td>Up to 400</td>
<td>8,65</td>
<td>20,8°C 72%</td>
<td>Up ± 6,75</td>
</tr>
</tbody>
</table>

Note: Up is the expanded uncertainty

### Table 4 - Microbiological purity of plant raw materials C.alatavicus

<table>
<thead>
<tr>
<th>Names of indicators</th>
<th>ND for test methods</th>
<th>ND requirements</th>
<th>Actual results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of viable aerobic microorganisms, CFU/g</td>
<td>SPh RK I, v. 1, p. 176</td>
<td>Not more than 10⁷</td>
<td>8,6x10⁵</td>
</tr>
<tr>
<td>Fungus, CFU/g</td>
<td>SPh RK I, v. 1, p. 176</td>
<td>Not more than 10⁸</td>
<td>2x10²</td>
</tr>
<tr>
<td>E. coli in 1.0 g</td>
<td>SPh RK I, v. 1, p. 181</td>
<td>Not more than 10²</td>
<td>less than 10</td>
</tr>
</tbody>
</table>
inal plant materials (MPM)" - of the SPh RK I, vol.3, p. 144-146, MPM must pass the pesticide residue test. The test was carried out in accordance with General pharmacopoeia article (GPhA) 1.5.3.0011.15 "Determination of the content of residual pesticides in medicinal plant materials and herbal medicinal products by gas chromatography" (State Pharmacopoeia of the Russian Federation (SPh RF), XIV edition, vol. 2. – Moscow, 2018. - 1449 p.). Radionuclides. According to the general monograph "Medicinal plant materials" - SPh RK I, vol.3, p. 144-146 it is mandatory to determine radionuclides in plant materials. Determination of the specific activity of Sr-90 and Cs-137 in herbal medicines was carried out in accordance with the requirements of the GPhA 1.5.3.0001.15 "Determination of the content of radionuclides in herbal medicines and medicinal plant preparations" (SPh RF, XIV edition, vol. 2. - Moscow, 2018. - 1449 p.).

Microbiological purity. In the microbiological analysis of herbal medicines, quantitative determination of aerobic microorganisms, yeasts and moulds is carried out, as well as the isolation of certain types of pathogenic bacteria. According to article PhEAEU I, vol.1, 2.3.1.4 "Requirements for the microbiological purity of pharmaceutical substances of plant origin, herbal medicinal products and extracts used for their production, a limited number of microorganisms is allowed in medicinal products in the absence of certain species, dangerous to human health". The analysis was carried out in accordance with the GPhA 2.6.12 and 2.6.13 of the SPh RK I, vol.1 [8, 9].

**Results and their discussion.** Heavy metals and arsenic. The maximum allowable content of heavy metals and arsenic should not exceed the values given in the normative documents. The determination of the compliance of heavy metals and arsenic in raw materials with acceptable standards is shown in Table 1.

The study results showed that in the test sample, Cd, Hg and As were below the limit of quantitation (LOQ), and the Pb content was 0.1164 µg/kg. Pesticides. The results of the GC-MS analysis showed that the content of α and β isomers of HCCH is below the value of the limits for the permissible content of residual pesticides, including γ-HCCH is 0.00215 µg/kg. Traces of pesticides 4,4-DDT and 4,4-DDE amounting to 0.00546 µg/kg were found. According to the SPh RF, the content of aldrin in herb medicines is not allowed, and according to the European Pharmacopoeia (EPh), the content of residual aldrin is not more than 0.05 µg/kg. The research results show the absence of this pesticide [10, 11].

The traces of the content of residual pesticides were compared with the values of the limits of the residual pesticides permissible content (APSOP), given in the SPh RF and the EPh. The comparison results are shown in Table 2.

The results of studies of medicinal plant materials showed the practical absence of organochlorine pesticides in the analyzed material. Radionuclides. It has been experimentally established that the plant raw materials C.alatavicus are environmentally safe for such ecotoxics as radionuclides. The results showed the content of strontium-90 and cesium-137 in the studied plant within acceptable limits (Table 3).

### Microorganisms. The standards recommended by the Pharmacopoeia of the Republic of Kazakhstan were used to assess the quality in terms of microbiological purity. Table 4 shows the results of determining the microbiological purity of the studied plant.

### Conclusion. Thus, to establish the safety of the C.alatavicus raw materials, we studied the content of heavy metals, radionuclides, residual pesticides, as well as the microbiological purity of the raw material. The content of all indicators corresponds to acceptable standards. It has been established that the studied plant raw material C.alatavicus complies with the requirements of regulatory documents in terms of environmental safety. We believe that the use of cultivated plant materials as a phytosubstance has a positive effect on the quality of the finished product.

**REFERENCES**


Авторы. Барлық авторлар осы мақаланы жазуға тең дәрежеде қатысты.
Мүдделер қақтығысы – мәлімделген жоқ.
Бұл материал басқа басылымдарда жариялау үшін мәлімделген және басқа басылымдардың қарауына ұсынылмagan.
Осы жұмысты журізіз кезінде сырты уымды мен медициналық қәдімдердің қаржыландыруы жасалған жоқ.
Қаржыландыру жұрғізілмеген.

Вклад авторов. Все авторы принимали равнозначное участие при написании данной статьи.
Конфликт интересов – не заявлен.
Данный материал не был заявлен ранее, для публикации в других изданиях и не находится на рассмотрении другими издательствами.
При проведении данной работы не было финансирования сторонними организациями и медицинскими представительствами.
Финансирование – не проводилось.

Authors’ Contributions. All authors participated equally in the writing of this article.
No conflicts of interest have been declared.
This material has not been previously submitted for publication in other publications and is not under consideration by other publishers.
There was no third-party funding or medical representation in the conduct of this work.
Funding - no funding was provided.

Сведения об авторах
Allambergenova Z.B., Master, Lecturer, Department of Engineering Disciplines, S.D. Asfendiyarov Kazakh National Medical University, zoyaallambergen@mail.ru, Almaty, Kazakhstan, +77472565695;
Sakipova Z.B., Doctor of Pharmacy, Professor, Dean of the School of Pharmacy, S.D. Asfendiyarov Kazakh National Medical University, sakipova.z@kaznmu.kz, Almaty, Kazakhstan, +77772350202; https://orcid.org/0000-0003-1400-1971
Aliyev N.U., Doctor of Chemical Sciences, Professor of the Department of Chemistry, S.D. Asfendiyarov Kazakh National Medical University, alliev_n_50@mail.ru, Almaty, Kazakhstan, +7701 7227613;
Kozhanova K.K., Ph.D., Associate Professor, Head of the Department of Engineering Disciplines, S.D. Asfendiyarov Kazakh National Medical University, kaldanay_k@mail.ru, Almaty, Kazakhstan, +77017388625;
Kadyrbaeva G.M. Master, Lecturer, Department of Engineering Disciplines, S.D. Asfendiyarov Kazakh National Medical University, chiinara_k@mail.ru, Almaty, Kazakhstan, +77476750317.