Potential areas of cultivation of Achillea nobilis in the conditions of the Orenburg region

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Abstract. Achillea nobilis L. is a promising medicinal plant in the world. Ecological factors influence the metabolism of plants and their chemical composition. Researches were conducted in 5 districts of the Orenburg region (Perevolotsky, Aleksandrovsky, Pervomaysky, Svetlinsky and Buzuluksky). The spatial and demographic structure of cenopopulations on the ability of accumulation of biologically active substances (BAS) during the procurement of medicinal raw materials A. nobilis was analyzed. As a result of the experiments, it was found that soil fertility (humus content) directly affects the accumulation of pharmacologically active substances in A. nobilis. It has been established that the southeastern part of the Orenburg region is most suitable for growing medicinal raw materials of A. nobilis.

1. Introduction
The genus Achillea L. belongs to Asteraceae (Compositae), the largest family of vascular plants. Representatives of this genus are widely distributed throughout the world and have been used in medicine since ancient times [1]. Achillea nobilis L. is one such species mentioned. This species is not used in official medicine; however, it is a close phylogenetic species with the pharmacopoeial plant Achillea millefolium L.

Interest in herbal treatments or herbal medicines has been growing recently. Herbal medicine has great advantages, for example, the effectiveness and the almost complete absence of side effects, especially harmful [2, 3, 4], the relative cheapness and availability of herbal remedies for all segments of the population [5, 6].

The expansion of the pharmaceutical market with herbal preparations based on A. nobilis is relevant. Therefore, the aim of the work is to investigate the pharmacological composition of A. nobilis for the selection of recommendations for the cultivation of a potential medicinal plant in the Orenburg region.

To achieve the goal set the following tasks:
- zoning of study sites,
- conducting qualitative research of the main groups of biologically active substances A. nobilis,
- analysis of the spatial and demographic structure of the A. nobilis price populations.
2. Materials and research methods

2.1. Place of study
The study was conducted in the Orenburg region - the subject of the Russian Federation. The area of the Orenburg region is 123,702 km², with a population of 1,963,007 people. The climate is sharply continental. The continentality of the climate is most clearly manifested in the characteristics of the temperature regime, in the insufficiency and instability of soil moisture. The soils of the Orenburg region are characterized by a non-washing regime, mostly alkaline, often with increased carbonate content. The whole area belongs to the chernozem-steppe zone. The prevailing part of the territory is represented by black earth soils, a small amount of dark chestnut soils and sodic complexes, as well as along river valleys and floodplains by meadow soils (Table 1, Figure 1).

Table 1. Soil types of the Orenburg region

| Types of soils of the Orenburg region | Square, % | Humus content, % |
|--------------------------------------|-----------|-----------------|
| Chernozems, including.:              |           |                 |
| alkaline and typical                 | 8         | 6-12 (до 15)    |
| ordinary                             | 24        | 6-10            |
| south                                | 28        | 4-8             |
| Dark cachatan                        | 7         | 3-5             |
| solonetz complexes                   | 19        | 2-3             |
| Meadow and floodplain                | 6         | 3-7             |
| Other                                | 8         | -               |

The flora of the vascular plants of the Orenburg region includes 1613 species belonging to 123 families and 551 genera. The most numerous families of regional flora are Asteraceae, Poaceae, Fabaceae, Brassicaceae, Caryophillaceae, Chenopodiaceae. The leading ecological groups are mesophytes (34.5%) and xerophytes (21.8% of species).

Study sites
For the sampling of plant materials Achillea nobilis, 5 experimental sites were set up, located in various districts of the Orenburg region (Table 2). Research sites were established considering various types of soil (Fig. 2).
Figure 1. Soil map of the Orenburg region

Table 2. Collection points for A. Nobilis in the Orenburg Region with indication of reference areas and soil types

| №  | Reference area          | N       | E       | Soil types                  |
|----|-------------------------|---------|---------|-----------------------------|
| 1. | Neighborhood Ponomarevka village | 53.31127° | 54.13532° | Leached and Chernozems |
| 2. | Neighborhood Aleksandrovka village | 52.61469° | 53.25036° | Common black soil          |
| 3. | Neighborhood village Pervomaysky | 51.89363° | 51.66634° | Southern Black Soils       |
| 4. | Neighborhood village Svetly | 50.82719° | 60.87422° | Dark chestnut soils         |
| 5. | Neighborhood Buzuluk     | 52.77050° | 52.29537° | solonetiz complexes         |
Figure 2. Map of study areas of the Orenburg region

Table 3. Solubility of the main groups of plant substances

| Substance groups | H₂O | H₂O + t⁰ | H₂O – organic solvents | Polar organic solvents | Non-polar organic solvents |
|------------------|-----|----------|------------------------|------------------------|--------------------------|
| Alkaloids        | +   | +        | +                      | +                      | +                        |
| Essential oils   | -   | -        | +                      | +                      | +                        |
| Flavonoids -glycons | -   | bounded | +                      | +                      | +                        |
| Flavonoids -glycosides | +   | ly⁰     | +                      | +                      | -                        |
| Tannins - hydrolyzable | +   | +        | +                      | +                      | -                        |
| Tannins - condensed | -   | +        | +                      | +                      | boundedly                |
| Saponins         | boundedly | + | +                      | +                      | -                        |

² boundedly

2.2 Sample preparation of plant samples
The object of the study is the vegetative part A. nobilis.
Collection of plant samples was carried out during the growing season. The plants were studied using phytochemical methods to identify complexes of biologically active substances. Analytical samples for research on qualitative reactions were formed based on OFAS.1.1.0005.15.

2.3 Qualitative research of BAS in samples A. nobilis
To carry out qualitative reactions, extracts of plant materials were used, considering the nature of the main groups of plant biologically active substances and the associated solubility (Table 3). With the obtained extracts, qualitative reactions were performed on the studied groups [7].

The qualitative determination of alkaloids was performed using a Bouchard-Wagner-Lugol reagent (a solution of iodine in potassium iodide). The presence of alkaloids in the raw materials is confirmed by the appearance of a noticeable turbidity and the formation of drilling sediment.

Essential oils were determined by the reaction of extraction from plant materials with iron (III) chloride. The appearance of grayish-green staining with a positive reaction.

Qualitative analysis of flavonoids was performed by cyanidin sample (Shinod sample), using metallic magnesium in concentrated hydrochloric acid. Red staining indicates the presence of alkaloids in raw materials. For the control confirmation of the presence of alcalloids, a complex formation reaction was carried out (with aluminum salts), which is manifested by yellow or yellow-green staining.

Tannins were confirmed by qualitative reaction with ammonium-iron alum. The appearance of black and blue coloring indicates the presence of hydrolyzable tannins, black-green and black coloring - condensed tannins.

Saponins detected a breakdown of foaming. The presence of steroid saponins is confirmed by the formation of a rich and persistent foam.

The results were subjected to statistical processing.

3. The discussion of the results
The study of the leading groups of biologically active substances of plant materials, which determine the characteristic pharmacotherapeutic effect of the herbal remedies, as well as the search and prediction of previously unknown properties of this potential medicinal plant material, has a special methodological significance.

As a result of qualitative studies of plant materials A. nobilis, an increased concentration of the following BAS groups was noted in comparison with the available literature data: alkaloids and essential oils (from plants collected on leached chernozem soils), flavonoids (from plants growing on leached chernozem, chernozem ordinary, chernozem southern and dark chestnut soils). The same underestimation of the concentration of essential oils and tannins for representatives of A. nobilis growing on dark chestnut soils and sodic complexes is noted. However, these soil types are quite rare for the studied area [8]. During the analysis, it was noted that elevated concentrations of the main studied groups of biologically active substances are in direct correlation with the increased content of nitrates in the soil and the smallest amount of chlorides and sodium salts, bearing in mind the presence of humus in the soil (Table 4).

Since most of the Orenburg region is occupied by carbonate varieties of all types of chernozem (up to 60%), this makes it possible to grow the studied species of A. nobilis in this area.

However, when planning the preparation of medicinal plant materials, in addition to the choice of culture for cultivation, it is necessary to consider anthropotechnological factors [9-11].

So, on the presented area there are areas with increased anthropogenic loads. This is the Orenburg and Orsky (Novotroitsk, Gai) district due to the presence of the Gas Processing and Helium Plant, located just 30 km from Orenburg. Oil and gas areas in the western part of the region (from Buguruslansky in the north to Pervomaisky in the south), Kuvandyk District (Kuvandyk, Mednogorsk), where the cryolite plant and the copper-smelting combine are located, falls into this category [12]. These features of the intended area of cultivation and procurement of plant materials must be taken into account in order to obtain environmentally safe medicinal raw materials.
Table 4. Qualitative study of BAS raw materials A. nobilis, collected from different types of soils of the Orenburg region

|                          | Alkaloids | Flavonoids | Essential oil | Tannids | Saponins | Saponins |
|--------------------------|-----------|------------|---------------|---------|----------|----------|
| Black and black chernozems | L<sup>a</sup> | O<sup>b</sup> | L   | O   | L   | O   | L   | O   |
| Common black soil        | +         | +          | +   | ++  | ++  | +   | ++  | -   |
| Southern Black Soils     | +         | +          | +   | ++  | ++  | +   | ++  | -   |
| Dark chestnut soils      | +         | +          | ++  | ++  | +   | ++  | -   | -   |
| Solontsovye complexes   | +         | +          | ++  | ++  | +   | ++  | -   | -   |

<sup>a</sup> literary data  
<sup>b</sup> results of experience / research  
<sup>c</sup> presence, noticeable reaction  
<sup>d</sup> significant amount, pronounced reaction  
<sup>e</sup> high content, pronounced reaction

4. Conclusions
The most favorable area for growing A. nobilis is the southeastern part of the Orenburg region under study, which is rich in fertile chernozem soils and is without anthropogenic stresses.

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