# НАУЧНЫЕ ОБЗОРЫ И СООБЩЕНИЯ

# SCIENTIFIC REVIEWS AND REPORTS

**DOI: 10.12731/wsd-2017-3-76-86**
**UDC 615.451.16:633.888.271**

## EVALUATION OF CRITERIA FOR THE EFFICIENCY OF THE EXTRACTION PROCESS OF ROOT AND RHIZOMES OF TURKESTAN VALERIAN

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*The goal is to calculate the efficiency criteria of the technological process of percolation of Turkestan valerian roots and rhizomes, to work out an optimal technology for obtaining a thick extract of Turkestan valerian.*

***Materials and methods.*** *In the experiment used roots and rhizomes of Turkestan valerian, purified water and ethanol of 96% pharmacopoeial quality.*

*When determining the optimum extraction conditions 70% ethyl alcohol was used as the extractant. The extraction method is percolation. Each extract fraction was taken at a DER 1:1 step, the amount of dry residue in each fraction was estimated and the main indices of the process dynamics were calculated.*

***Results.*** *The total yield of extractives from 100 g of the raw materials was 10.79 g, which is more than 12.44%. The maximum number of stages of extraction for obtaining a thick extract is 7, a further increase in portions of the extractant does not lead to a significant increase in the yield of the finished product, which indicates the depletion of the raw material.*

*The optimal technology for getting a thick extract consists of the following classical steps: grinding raw materials, preparing the extractant, preparing herbal raw materials, infusion, percolation, settling, filtration, evaporation, packaging and marking.*

***Conclusion.*** *Based on the conducted research, a technology for obtaining a thick extract from the roots and rhizomes of Turkestan valerian has been tested and experimentally substantiated, a laboratory regulation and methods for its standardization have been developed.*

***Keywords:*** *Turkestan valerian (V. turkestanica Sumn.); thick extract; efficiency criteria; ethyl alcohol; temperature; speed.*

# ОЦЕНКА КРИТЕРИЕВ ЭФФЕКТИВНОСТИ ПРОЦЕССА ЭКСТРАКЦИИ КОРНЕЙ И КОРНЕВИЩ ВАЛЕРИАНЫ ТУРКЕСТАНСКОЙ

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*Целью работы является проведение расчетов критериев эффективности технологического процесса перколяции корней и корневищ валерианы туркестанской, отработать оптимальную технологию получения густого экстракта валерианы туркестанской.*

***Материалы и методы.*** *В эксперименте использовали корни и корневища валерианы туркестанской, воду очищенную и спирт этиловый 96% фармакопейного качества.*

*При определении оптимальных условий экстрагирования использовали в качестве экстрагента спирт этиловый 70 %. Метод экстракции – перколяция. Каждая фракция экстракта отбирали с шагом DER 1:1, оценивали количество сухого остатка в каждой фракции и рассчитывали основные показатели динамики процесса.*

***Результаты.*** *Общий выход экстрактивных веществ из 100 г сырья составил 10,79 г, что составляет более 12,44%. Максимальное количество ступеней экстракции для получения густого экстракта равно 7, дальнейшее увеличение порций экстрагента не приводит к значительному увеличению выхода готового продукта, что свидетельствует об истощении исследуемого сырья.*

*Оптимальная технология получения экстракта густого состоит из следующих классических стадий: измельчение сырья, приготовление экстрагента, подготовка лекарственного растительного сырья, настаивание, перколяция, отстаивание, фильтрация, упаривание, упаковка и маркировка.*

***Заключение.*** *Таким образом на основании проведенного исследования отработана и экспериментально обоснована технология получения гу-*

*стого экстракта из корней и корневищ валерианы туркестанской, разработан лабораторный регламент и разработаны методики для его стандартизации.*

***Ключевые слова:*** *валериана туркестанская (V. turkestanica Sumn); густой экстракт; критерии эффективности; спирт этиловый; температура; скорость.*

Turkestan valerian (V. turkestanica Sumn.) is a perennial herbaceous plant with a straight or at the bottom short rising stem of 30–80 (100) cm in height and a shortened rhizome with numerous dark brown cord-like lobes 1–2 mm thick. Basal leaves are lyrate-pinnately-dissected, with 3–5 pairs of lateral, entire marginal, ovate-lanceolate segments, 25–30 mm long and 4–11 mm wide; terminal portion is slightly larger than lateral segments, round or oblong-ovate, 30–40 mm long and 10–20 mm wide. Inflorescence is at first capitate, flowers are lilac, up to 7 mm in length; fruits are 4 mm long and 1.5 mm wide, elongated, brown. It blossoms in June, the fruits are ripen in July-August. It grows on subalpine and alpine meadows, in spruce forests, on forest and flood meadows, grassy slopes of gorges up to 2000–4000 m in height [1].

Turkestan valerian is characterized by the Central Asian type of area. In Kazakhstan it is found in the Dzungarian Alatau, the Zailiysky and Kungei Alatau, Ketmen, the Terskey Alatau, the Chu-Ili mountains, the Kirghiz Alatau, the Karatau [2, 3]. Although this species is widely distributed on the territory of Kazakhstan, the cultivation of the species is of practical importance for maintaining the consistency of the composition of biologically active substances and the manifestation of their pharmacological activity [4].

The goal is to calculate the efficiency criteria of the technological process of percolation of Turkestan valerian roots and rhizomes, to work out an optimal technology for obtaining a thick extract of Turkestan valerian.

## Materials and methods

Roots and rhizomes of Turkestan valerian were collected in the mountains of the Zailiysky Alatau in late August, 2016 and represent a whole dried raw material. The following ingredients were used in the preparation of the extractant: purified water and ethanol of 96% pharmacopoeial quality.

When determining the optimum extraction conditions 70% ethyl alcohol was used as the extractant. Each extract fraction was taken at a DER 1:1 step, the amount of dry residue in each fraction was estimated and the main indices of the process dynamics were calculated.

Percolation was carried out using a laboratory filtration extractor. 100 g of crushed (3–5 mm) roots and rhizomes of Turkestan valerian were loaded into the extractor, 70% ethanol was poured in and infused for 24 hours. Then the percolation process was carried out; the speed was approximately 3–4 ml/min. Samples of the extract were collected separately with a DER 1:1 step. The extraction process was carried out until a total extract of DER 1:10 was obtained. For each sample of the extract a dry residue was determined and the basic physicochemical characteristics were fixed.

The content of the dry residue $A_n$ in individual portions of the extracts $V_n$ obtained by a certain extractant at a certain ratio of raw material: extract was calculated by the formula, g [5]:

$$A_n = \frac{\omega_n \times V_n}{100} \quad (1)$$

where: $V_n$ – is the volume of a separately collected portion of the liquid extract obtained by a certain extractant at a raw material: extract (1:1) ratio, ml;

$\omega_n$ – is the dry residue in a separately collected portion of extract $n$,%.

The content of the dry residue $B_n$ in the total extracts $V_{n+1}$ obtained by a certain extractant at a certain ratio of raw material: extract was calculated by the formula, g [5]:

$$B_n = \sum_{n=1}^{n} A_n \quad (2)$$

where: $A_n$ – the dry residue in a separately collected portion of the extract $V_n$, g.

The content of the dry residue $C_n$ in the total extracts $V_{n+1}$, obtained by a certain extractant at a certain ratio of raw materials: extract at the stage, was calculated by the formula, % [5]:

$$C_n = \frac{B_n}{V_{n+1}} * 100\% \quad (3)$$

where: $V_{n+1}$ – the volume of the total extract in the stage, ml;

$B_n$ – the content of the dry residue in the total extracts $V_{n+1}$, g.

The yield of extractive substances (absolutely dry extract) $D_n$ of each fraction by a certain extractant at a certain raw material: extract ratio was calculated by the formula,% [5]:

$$D_n = \frac{B_n}{m_c} * 100\% \quad (4)$$

where: $m_c$ is the mass of the raw material loaded into the extractor, g;

$B_n$ – the content of the dry residue in the total extracts $V_{n+1}$, g.

## Results of the study

Table 1 presents the data of the experiments and calculated data of the main parameters of the dynamics of the percolation process of Turkestan valerian fragmented roots and rhizomes by 70% ethanol at a certain ratio of raw material: extractant. The total yield of extractives from 100 g of the raw materials was 10.79 g, which is more than 12.44%.

*Table 1.*

**Calculated data of the main indicators of the dynamics of the Turkestan valerian percolation process**

| № | Volume of a separate portion of extract, $V_n$ | Volume of the total extract $V_{n+1}$ in the stage, ml | Content of dry residue, $\omega_n$, g/100 ml | Content of dry residue, $A_n$, g | Content of dry residue, $B_n$, g | Content of dry residue, $C_n$, % | Dry extract yield $D_n$, % |
|---|---|---|---|---|---|---|---|
| 1 | 100 | 100 | 2,45 | 2,45 | 2,45 | 2,45 | 2,45 |
| 2 | 100 | 200 | 2,25 | 2,25 | 4,70 | 2,35 | 4,70 |
| 3 | 100 | 300 | 1,79 | 1,79 | 6,49 | 2,16 | 6,49 |
| 4 | 100 | 400 | 1,91 | 1,91 | 8,40 | 2,10 | 8,40 |
| 5 | 100 | 500 | 1,00 | 1,00 | 9,40 | 1,88 | 9,40 |
| 6 | 100 | 600 | 0,71 | 0,71 | 10,11 | 1,69 | 10,11 |
| 7 | 100 | 700 | 0,54 | 0,54 | 10,65 | 1,52 | 10,65 |
| 8 | 100 | 800 | 0,05 | 0,05 | 10,70 | 1,34 | 10,70 |
| 9 | 100 | 900 | 0,05 | 0,05 | 10,75 | 1,19 | 10,75 |
| 10 | 100 | 1000 | 0,05 | 0,05 | 10,80 | 1,08 | 10,80 |

In order to determine the optimum conditions for extraction of raw materials, diagrams of the dependence of the main criteria of extraction process efficiency on the change in the ratio «raw material: extract» were constructed for each of the experiments.

The nature of the change in the process evaluation criteria under study in the dynamics of the «raw material: extract» ratio change is shown in Figures 1–2.

The maximum number of stages of extraction for obtaining a thick extract is 7, a further increase in portions of the extractant does not lead to a significant increase in the yield of the finished product, which indicates the depletion of the raw material.

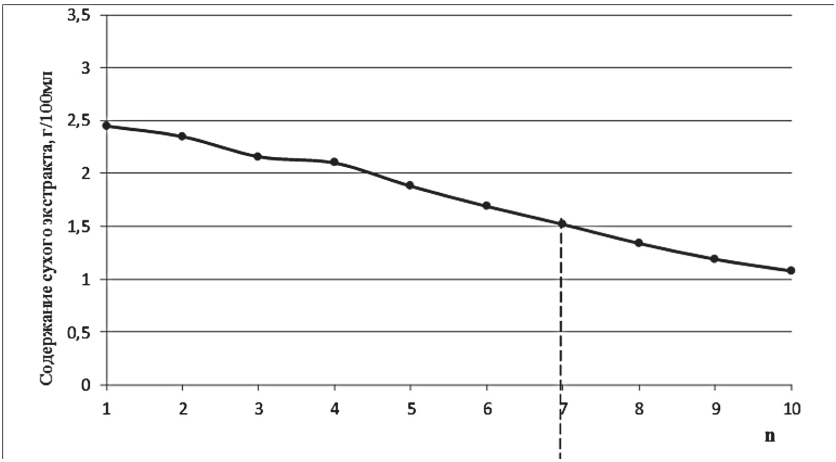


**Fig. 1.** Diagram of the dry residue content in the n-sample of liquid extracts

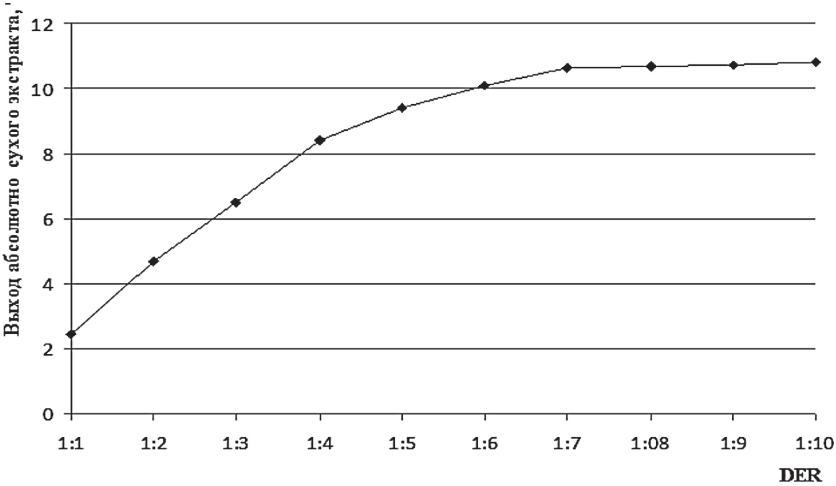


**Fig. 2.** Diagram of the yield of an absolutely dry extract, depending on DER

Based on the data obtained the optimal technology for getting a thick extract has been worked out, which consists of the following classical steps: grinding raw materials, preparing the extractant, preparing herbal raw materials (HRM), infusion, percolation, settling, filtration, evaporation, packaging and marking (Figure 3).

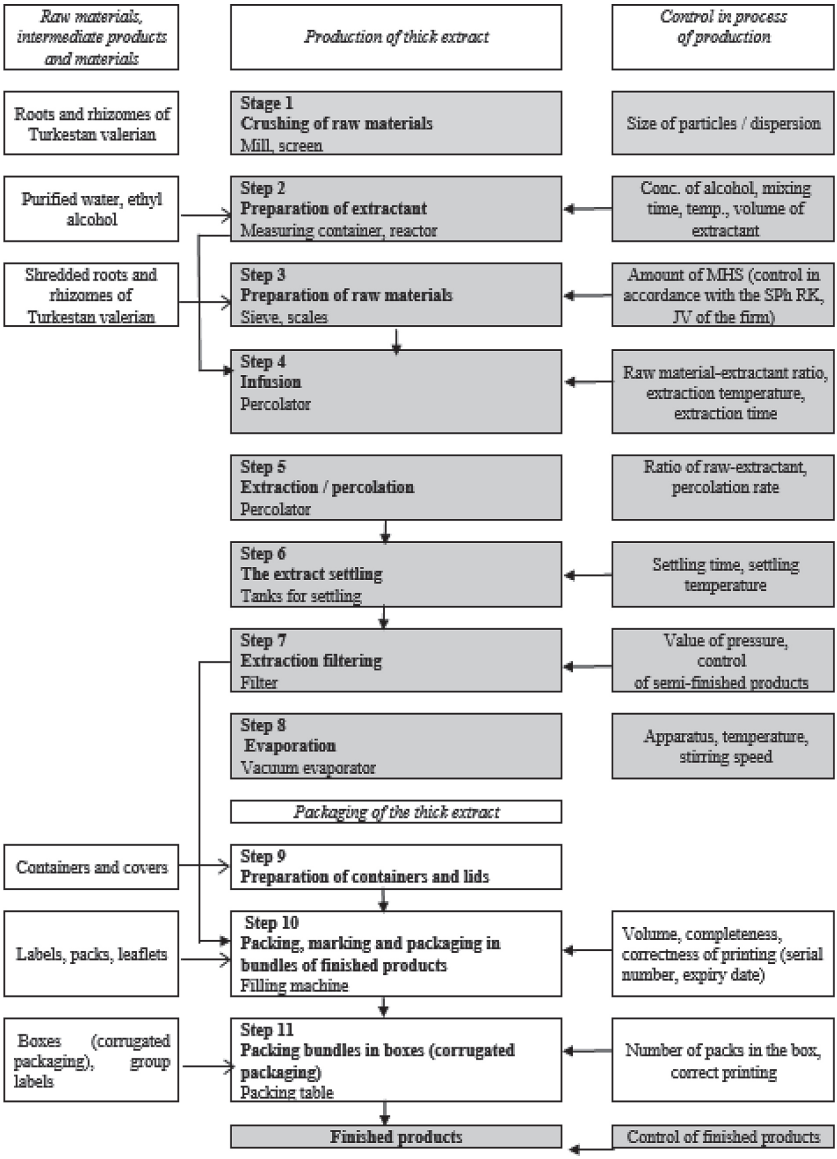


**Fig. 3.** Technological scheme for producing a thick extract from roots and rhizomes of Turkestan valerian

Roots and rhizomes of Turkestan valerian are crushed on a grass cutter to a size of 3–5 mm. A regulated amount of the crushed raw material is loaded into the percolator with a false bottom, filled with the calculated amount of ethyl alcohol 70% taking into account the absorption coefficient and infused for 24 hours. Then the process of extraction (percolation), draining of the percolate and simultaneous feeding of the extractant is carried out at a speed of 3–4 mils/min. The resulting semi-finished product is left to settle at a temperature of no higher than 8°C for 24 hours. The settled extract is separated from the ballast mass, subjected to a three-stage filtration (the filter pore size: 1.0 μm, 0.5 μm, 0.65/0.45 μm), evaporated in a rotary vacuum evaporator at the specified parameters (temperature 40±1°C, rotation speed 80–100 rpm, vacuum 0.08 mPa), packed in containers of orange glass for pharmaceutical use, and marked in accordance with the requirements of order No. 227 of 04/16/2015 [4].

Thus, based on the conducted research, a technology for obtaining a thick extract from the roots and rhizomes of Turkestan valerian has been tested and experimentally substantiated, a laboratory regulation and methods for its standardization have been developed.

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