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Section 1. Biology

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PROTEIN CONTENT OF SOME *RUMEX* SPECIES (*POLYGONACEAE*)

Abstract. The aim of this study is the comparative analysis of the quantitative composition of protein content of five *Rumex* species: *Rumex pamiricus* Rech. f., *Rumex conglomeratus* Murray., *Rumex confertus* Willd., *Rumex acetosa* L. and *Rumex aquaticus* L. growing in similar environmental conditions. Based on the results obtained, it was found that the protein content in the leaves was higher than in the roots and seeds of the existing plants. The protein content of *Rumex aquaticus* demonstrated the highest values than other species (Table 1). The total proteins content in the roots of *Rumex aquaticus* 9.25%, in the seeds 9.11%, in the leaves 19.75%. This amount is a high figure for the plant. As a result our research, we have found a new source rich in protein.

Keywords: *Polygonaceae* L., *Rumex pamiricus* Rech. f., *Rumex conglomeratus* Murray., *Rumex confertus* Willd., *Rumex acetosa* L., *Rumex aquaticus* L., sorrel, dock, protein, superfood

1. Introduction

The nutrients essential for life are proteins, fat and carbohydrates, all contribute to caloric content of the dietary, minerals including trace elements, vitamins and water. Numerous studies, including in man, have demonstrated clearly that life may be sustained by nutrient mixtures in which every component is definable chemically and soluble in water. Most of the countries of the world have been facing malnutrition problems. The deficiency of protein in human food and animal feed is well recognized. The need of the good quality of proteins has been increasing due to rapid growth of population. It has been reported that in Uzbekistan the protein gap would continue to increase unless well-planned measures are adopted to tackle the situation. It is therefore imperative to increase protein production by utilizing all the available ways and means.

The name of *Rumex* derived from the Latin word for dart, alluding to the shape of the leaves. It is the largest genus of family *Polygonaceae* [1]. Plants of the genus *Rumex* L. (dock, sorrel) are widely distributed in North America, Central and Eastern Europe, Kazakhstan, the Far East, and partly in the Caucasia, Russia, and East Asia [2; 3; 4; 5]. This genus includes more than 250 species distributed worldwide. 16 species grow in Uzbekistan. *Rumex pamiricus* Rech. f, *Rumex conglomeratus* Murray, *Rumex confertus* Willd, *Rumex acetosa* L. and *Rumex aquaticus* L. are the most common species among them [6; 7; 8]. Since ancient times *Rumex L.* species have been well known for their use in traditional medicine, due to therapeutic efficacy and various biological activities [9]. The consumption of wild edible plants has been an integral part of human nutrition and traditional medicine since ancient times [10; 11]. Wild plants are known to be a good source of primary nutritional compounds (proteins, fats, sugars, vitamins, and minerals) [12]. Wild plants contain various biologically active components that demonstrated health benefits effects (flavonoids, phenolic acids, anthocyanins, tannins, terpenoids, steroidal saponins, glucosinolates, and so on) [11]. This shows their potential as nutritional supplements, feed additives, and medicinal agents [11; 13]. Among wild plants, *Rumex* plants have a great potential. They are already widely used as food, fodder, melliferous, and medicinal plants [5; 14; 15]. In some countries, the leaves of *Rumex* plants (such as R. *vesicarius*, R. *acetosella*, R. *abyssinicus*, R. *crispus*, R. *induratus*, R. *sanguineus*, R. *obtusifolius*, R. *tuberosus*, R. *thyrsiflorus*, and R. *acetosa*) are used for food, mainly as salads [16; 17]. According to the literature informations, several *Rumex* species are included in the pharmacopoeias of various countries. For example, *Rumex crispus* is listed in the American Herbal Pharmacopoeia as a general detoxifier and an agent for skin treatment [18]. The State Pharmacopoeia of the Russian Federation includes the roots of *Rumex confertus* Willd. as a herbal medicine, which is used in the treatment of liver diseases, dysentery, pulmonary, and uterine bleeding, as well as a laxative [19; 20]. The aim of this research is to study and compare the amount of protein between of Some *Rumex* Species.

2. Materials and Methods

2.1. Plant Material

Plant leaves, roots and seeds of the following species were used as the objects of study: *Rumex pamiricus* Rech. f., *Rumex acetosa* L., *Rumex confertus* Willd, *Rumex conglomeratus* Murray and *Rumex aquaticus* L. (Figure 1). Leaf samples (during the flowering period on May 2021), seeds and roots (on July, September 2021) of the plants were collected from Botanic Garden, Tashkent, Uzbekistan.

Figure 1. The leaves of *Rumex pamiricus* (1); the seeds of *Rumex acetosa* (2); the seeds of *Rumex confertus* (3); the roots of *Rumex conglomeratus* (4); the aerial part of *Rumex aquaticus* (5)

2.2. Determination of Total Protein Content

The Kjeldahl method was used to determine the amount of protein. This method was performed using Nessler reagent. To determine the amount of protein, 0.1 g (to the nearest 0.001 g) of crushed plant samples were placed inside the tubes. To them were added 5 ml of concentrated H_2SO_4 (r 1,84 g/cm^3), 0,5 ml of 30% H_2O_2 or 0,2 ml of concentrated perchlorotic acid ($HClO_4$). Place the flasks in a sand bath or on a temperature-controlled plate, set the temperature to 4000C, and heat carefully. After 20 minutes, another 0.5 ml of 30% peroxide or 0.2 ml of concentrated perchlorotic acid is added to the flask to accelerate mineralization. The solution was heated until completely white (for 1 hour). The flasks were then kept on the plate for another 15–20 minutes and cooled. 10 ml of distilled water was added to the cooled flasks, the required amount of solution was transferred to 50 cm^3 flasks, distilled water was added and mixed. After mineralization, 0.3 ml of aliquot solution was added to 25cm^3 flasks, and distilled water was added to the 25cm^3 mark. 10% NaOH was added to the solution. To eliminate opalescence of the solution, 0.5 ml of 50% Segnet salt solution was first added to the tubes and then 1 ml of Nessler reagent. The solutions were then filled with distilled water to the mark of 50 cm^3 and mixed. In this case, the solutions must be clean. If the solutions are turbid, this indicates that the mineralization has not completely passed or that the reagents used are not clean. If the amount of protein in the samples is low, the color of the solution will be yellow, if large – the color will be orange. After 15 min, the optical density of the solutions was measured at a wavelength of l= 400 nm. The amount of protein in the studied samples was determined according to the following formula:

$$C = \frac{V * 100 * 5,7 * C_1}{H * A * 1000}$$

C – protein content,%

H – protein etalon content, g

V – volume, after sample division, ml

A – is the volume of the aliquot taken for colorimetry;

C – is the percentage of nitrogen in the aliquot section determined using a measurement chart, mg

1000 – copying coefficient, mg.

100 – copying coefficient,%.

6.25 – coefficient.

3. Results

In the protein content study of *Rumex aquaticus* demonstrated the highest values (Table 1). The total proteins content in the roots of *Rumex aquaticus* 9.25%, in the seeds 9.11%, in the leaves 19.75%. This is a high figure for a plant.

Table 1. – Protein content of some *Rumex* species in the leaves, seeds and roots

№	Plant name	Total protein content,%		
		Root	**Seed**	**Leaf**
1.	Rumex pamiricus Rech. f.	5.22	7.56	13.87
2.	Rumex confertus Willd	2.87	4.22	15.16
3.	Rumexconglomeratus Murray	6.02	5.16	17.14
4.	Rumex acetosa L.	5.10	7. 23	16.12
5.	Rumex aquaticus L.	9.25	9.11	19.75

Based on the results obtained, the protein content in the leaves was found to be higher than in the roots and seeds of the existing species. It was studied at the Institute of the Chemistry of Plant Substances named after Acad. S. Yu. Yunusov AS of Uzbekistan, Laboratory of Chemistry of high-molecular plant substances. The quantitative protein index of plants was determined at 400 nm on a spectrophotometer device using an improved Nessler reagent of the Kjeldahl method.

4. Discussion

Plants of the genus *Rumex* have traditionally been used as edible or medicinal plants in various regions of the world. However, today, their biotechnological potential is becoming evident, and these species can act as a resource of biologically active substances. The *Rumex* plants are abundant, undemanding, gain phytomass easily, and have a short vegetative cycle (and, as a consequence, can reproduce frequently through-out the year), thus they have a real advantage among wild plants of the temperate zone. It should also be noted that *Rumex* species have a high potential for regrowth after injury [20; 21; 22]. Aerial parts of many species (for example, *R. confertus, R. acetosella, R. acetosa* and *R. crispus*) are widely used for food. Plants are collected mainly in spring and are used as vegetables [14; 23; 24]. Moreover, the accumulated amount of research allows us to define the plants of this genus as a «superfood». Currently, «superfood» is defined as foods high in nutritional or biologically active phytochemicals beneficial to human health [25]. The results of our studies prove that plants of the genus *Rumex* can occupy a niche in the food industry and act as a functional food product.

5. Conclusion

The aim of this study is the comparative analysis of the quantitative composition of protein content of five *Rumex* species: *R. pamiricus, R. acetosa, R. confertus, R. conglomeratus* and *Rumex aquaticus* growing in similar environmental conditions. As we can see in Table 1, we have found a new source rich in protein. This suggests that *Rumex*-based foods can be rich sources of protein, and that *Rumex* species can be a solution to the problem of protein deficiency with their protein-rich content. The results of the study will allow to identify the most promising species for pharmaceutical and food use.

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Section 2. Mechanics

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IDENTIFICATION OF THE FLOW COEFFICIENT IN A TRUNCATED MODEL OF FLUID FILTRATION IN FRACTURED-POROUS MEDIA

Abstract. In this work, the inverse problem of determining the flow coefficient in the "truncated model" of homogeneous fluid filtration in fractured-porous media is posed and numerically solved. The second-order identification method was used to solve the problem. It has been established that the flow coefficient at various zero approximations with unperturbed initial data is restored quite well at a small number of iterations.

Keywords: identification method, inverse problem, filtration, fracture, porous block, solution stability.

The theory of filtration of homogeneous liquids in fractured-porous media (FPM) is given in [1; 2]. Based on this theory, the equation for the filtration of homogeneous fluid in the FPM in the plane-parallel case takes the form [1; 2].

$$\begin{cases} \beta_1^* \dfrac{\partial p_1}{\partial t} = \dfrac{k_1}{\mu}\dfrac{\partial^2 p_1}{\partial x^2} + \dfrac{\alpha_0}{\mu}(p_2 - p_1), \\ \beta_2^* \dfrac{\partial p_2}{\partial t} = \dfrac{k_2}{\mu}\dfrac{\partial^2 p_2}{\partial x^2} - \dfrac{\alpha_0}{\mu}(p_2 - p_1), \end{cases} \tag{1}$$

where α_0 – is the dimensionless flow coefficient depending on the geometric characteristics of the porous blocks; μ – dynamic viscosity of the fluid, p_1, p_2 – pressure in fractures and porous blocks, respectively, $\beta_l^* = \beta_{cl} + m_{0l}\beta_f$, k_l – permeability, m_{0l} – porosity at $p_l = p_0$, β_f – liquid compressibility coefficient, β_{cl} – medium compressibility coefficient, index $l = 1$ corresponds to fracture, $l = 2$ – porous blocks.

Warren and Ruth [3] took into account the compressibility of fractures, but neglected the movement of fluid in porous blocks, from (1) a system of equations is obtained

$$\begin{cases} \beta_1^* \dfrac{\partial p_1}{\partial t} = \dfrac{k_1}{\mu}\dfrac{\partial^2 p_1}{\partial x^2} + \dfrac{\alpha_0}{\mu}(p_2 - p_1), \\ \beta_2^* \dfrac{\partial p_2}{\partial t} + \dfrac{\alpha_0}{\mu}(p_2 - p_1) = 0, \end{cases} \tag{2}$$

which in some sources is called "truncated".

Models (1) and (2) are widely used in the process of developing oil deposits with fractured and fractured-porous reservoirs [4–8].

In this paper, using the system of equations (2), we solve the inverse problem of determining the flow coefficient α_0. The solution of the direct problem at certain points of the study area is taken as the initial data for the inverse problem. Therefore, a quasi-real computational experiment is being carried out.

The "truncated" model of filtration of a homogeneous liquid in a FPM (2) can be written as

$$\begin{cases} \dfrac{\partial p_1}{\partial t} = \dfrac{k_1}{\mu\beta_1^*}\dfrac{\partial^2 p_1}{\partial x^2} + \dfrac{\alpha_0}{\mu\beta_1^*}\left(p_2 - p_1\right) = 0, \\ \dfrac{\partial p_2}{\partial t} + \dfrac{\alpha_0}{\mu\beta_2^*}\left(p_2 - p_1\right) = 0, \quad 0 < x < L, \ 0 < t \le T. \end{cases} \tag{3}$$

For the system of equations (3), the initial and boundary conditions have the following form

$$p_1(0,x) = p_2(0,x) = p_0, \ \ p_0 = \text{const}, \ \ 0 \le x \le L, \tag{4}$$

$$-\frac{k_1}{\mu}\frac{\partial p_1}{\partial x}\bigg|_{x=0} = v_0 = \text{const}, \ \ p_1(t,L) = p_0, \ \ 0 < t \le T. \tag{5}$$

Problem (3)–(5) corresponds to the direct formulation. To solve the inverse problem by determining α_0 it is necessary to set additional conditions, for which we use the solution of problem (3) – (5) with known α_0 at given points of the region. Let such information be given at the point $x = 0$ as a solution $p_1(t,0)$, which we denote as $z(t)$. In the general case, when the inverse problem is not considered within the framework of a quasi-real experiment, $z(t)$ is a function determined experimentally (in laboratory or field conditions).

The inverse problem is posed as follows: to determine the flow coefficient α_0 from the minimum condition for the following functional

$$J(\alpha_0) = \int_0^T \left[p_1(t,0) - z(t)\right]^2 dt, \tag{6}$$

where $p_1(t,0)$ – solution of problem (3) – (5) for a given α_0.

The stationarity condition for the functional (6) $dJ(\alpha_0)/d\alpha_0$ has the form

$$\frac{dJ(\alpha_0)}{d\alpha_0} = 2\int_0^T \left[p_1(t,0) - z(t)\right] w_1(t,0)\,dt \equiv F(\alpha_0) = 0, \tag{7}$$

where $w_1 = \dfrac{\partial p_1}{\partial \alpha_0}$ – is the sensitivity function [9; 10] with respect to the coefficient α_0.

Differentiating the system of equations (3) with respect to the parameter α_0, we obtain the following system of equations

$$\begin{cases} \dfrac{\partial w_1}{\partial t} = \dfrac{k_1}{\mu\beta_1^*}\dfrac{\partial^2 w_1}{\partial x^2} + \dfrac{\alpha_0}{\mu\beta_1^*}\left(w_2 - w_1\right) + \dfrac{1}{\mu\beta_1^*}\left(p_2 - p_1\right) = 0, \\ \dfrac{\partial w_2}{\partial t} + \dfrac{\alpha_0}{\mu\beta_2^*}\left(w_2 - w_1\right) + \dfrac{1}{\mu\beta_2^*}\left(p_2 - p_1\right) = 0, \\ 0 < x < L, \ 0 < t \le T, \end{cases} \tag{8}$$

where $w_1 = \dfrac{\partial p_1}{\partial \alpha_0}$, $w_2 = \dfrac{\partial p_2}{\partial \alpha_0}$ – sensitivity functions [9; 10] by the coefficient α_0.

The initial and boundary conditions for the system of equations (8) are obtained from conditions (4), (5) by differentiation with respect to α_0:

$$w_1(0,x) = w_2(0,x) = 0, \ \ 0 \le x \le L, \tag{9}$$

$$-\frac{k_1}{\mu}\frac{\partial w_1}{\partial x}\bigg|_{x=0} = 0, \ \ w_1(t,L) = 0, \ \ 0 < t \le T. \tag{10}$$

Relation (7) can be considered as a non-linear equation with respect to α_0, which we will solve using Newton's iterative method [11]. Let α_0^s – be some approximate value of this parameter for the s-th iteration. Then the next approximation α_0^{s+1} is determined from

$$F\left(\alpha_0^s\right) + \frac{dF}{d\alpha_0}\left(\alpha_0^{s+1} - \alpha_0^s\right) = 0, \tag{11}$$

those

$$\alpha_0^{s+1} = \alpha_0^{s+1} - F\left(\alpha_0^s\right)\left[\frac{dF}{d\alpha_0}\right]^{-1}, \tag{12}$$

where

$$\begin{gathered} \frac{dF}{d\alpha_0} = \int_0^T \left\{\left[p_1(t,0) - z(t)\right]\omega_1(t,0) - \left[w_1(t,0)\right]^2\right\} dt, \\ \omega_1 = \frac{\partial w_1}{\partial \alpha_0} = \frac{\partial^2 p_1}{\partial \alpha_0^2}. \end{gathered} \tag{13}$$

Similarly, by differentiating system (8) with respect to α_0, the following system of equations is obtained

$$\begin{cases} \dfrac{\partial \omega_1}{\partial t} = \dfrac{k_1}{\mu\beta_1^*}\dfrac{\partial^2 \omega_1}{\partial x^2} + \dfrac{\alpha_0}{\mu\beta_1^*}(\omega_2 - \omega_1) + \dfrac{2}{\mu\beta_1^*}(w_2 - w_1), \\ \dfrac{\partial \omega_2}{\partial t} + \dfrac{\alpha_0}{\mu\beta_2^*}(\omega_2 - \omega_1) + \dfrac{2}{\mu\beta_2^*}(w_2 - w_1) = 0, \\ 0 < x < L,\ \ 0 < t \le T, \end{cases} \qquad (14)$$

where $\omega_1 = \dfrac{\partial w_1}{\partial \alpha_0} = \dfrac{\partial^2 p_1}{\partial \alpha_0^2}$, $\omega_2 = \dfrac{\partial w_2}{\partial \alpha_0} = \dfrac{\partial^2 p_2}{\partial \alpha_0^2}$.

The initial and boundary conditions for the function ω_1, ω_2 can be similarly obtained from conditions (11), (12) for the function w_1, w_2 by differentiating with respect to α_0:

$$\omega_1(0,x) = \omega_2(0,x) = 0,\ \ 0 \le x \le L, \qquad (15)$$

$$-\frac{k_1}{\mu}\frac{\partial \omega_1}{\partial x}\bigg|_{x=0} = 0,\ \ \omega_1(t,L) = 0,\ \ 0 < t \le T. \qquad (16)$$

The numerical algorithm for determining the coefficient α_0 by the Newton method can be constructed as follows: 1) The initial approximation α_0^0 is chosen (assuming $s = 0$); 2) Problems (3) – (5) and (8) – (10) are solved from $t = 0$ to $t = T$ and the functions p_1, w_1 are determined. The value of functional (6) and integral (7) is found; 3) The problem (14) – (16) is solved from $t = 0$ to $t = T$ and the function ω_1 is determined. The value of the integral (13) is found; 4) According to relation (12), the following approximation α_0^{s+1} is calculated; 5) Steps 2), 3), 4) are repeated until the conditions

$$\frac{\left|J^{s+1} - J^s\right|}{J^s} \le \varepsilon_1,\ \ \frac{\left|\alpha_0^{s+1} - \alpha_0^s\right|}{\left|\alpha_0^s\right|} \le \varepsilon_2.$$

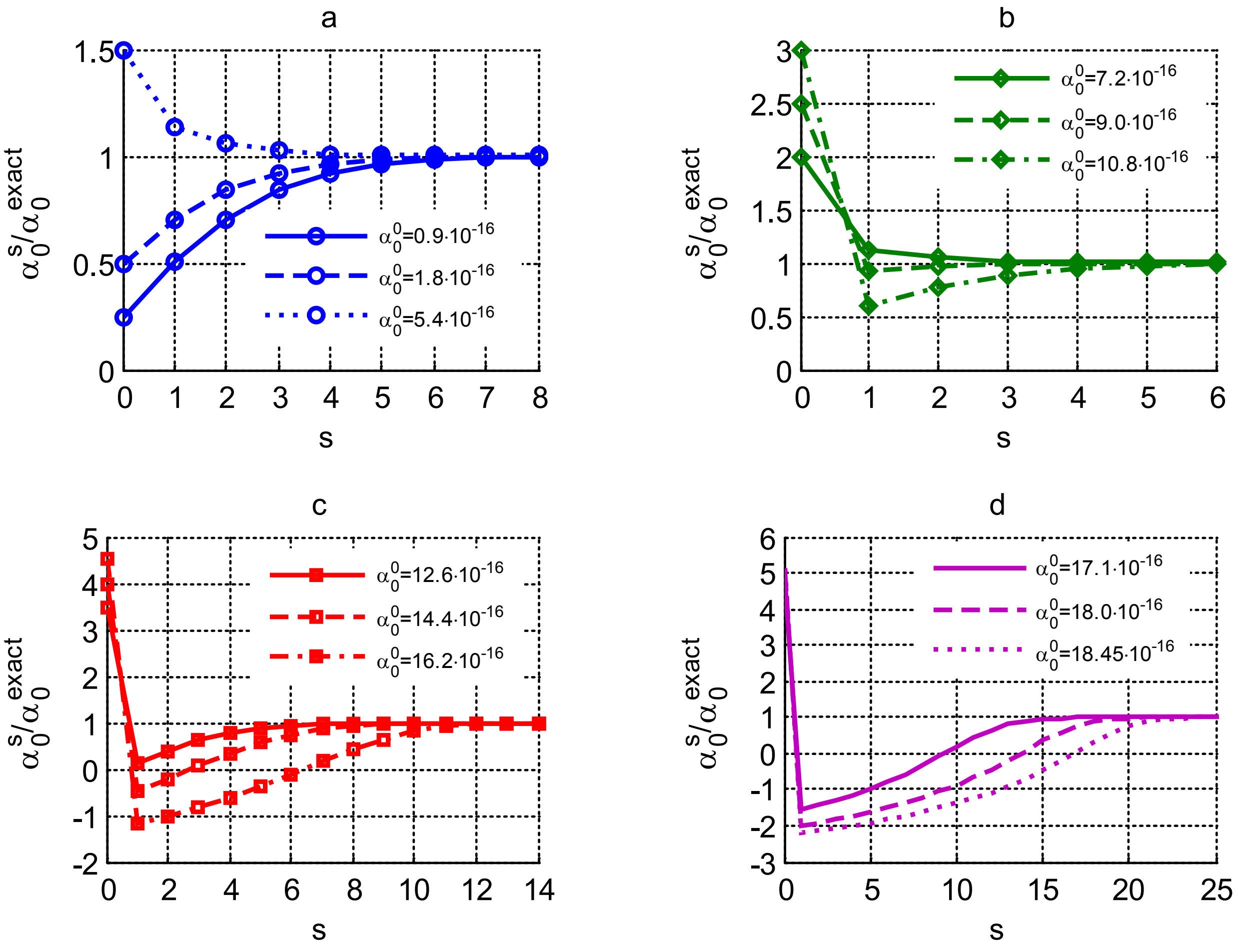

Figure 1. Recovery of the coefficient with unperturbed initial data (for $\delta = 0$), α_0^{exact} – is the value of the parameter α_0

Within the framework of a quasi-real experiment [12], the direct problem (3) – (5) with known $\alpha_0^{\text{exact}} = 3.6 \cdot 10^{-16}$ is first considered. This problem is solved numerically by the finite difference method [13]. According to the results of numerical calculations, the grid function $z^j = z\left(t_j\right),\ j = 0,1,...,M$ is determined. Also, when solving the inverse problem, the grid function $z\left(t\right)$ is noisy with random errors [12] as follows: $z_\delta^j = z^j + 2\delta\left(\sigma^j - 0{,}5\right)$, where σ^j – is a random function uniformly distributed over the interval $\left[0,1\right]$, δ – error level.

For the numerical solution of problem (3) – (5), the following initial values of the parameters were used: $T = 2000$ s, $L = 60$ m, $k_1 = 1 \cdot 10^{-12}$ m^2, $p_0 = 10$ MPa, $\mu = 2.5 \cdot 10^{-8}$ MPa·s, $\beta_2^* = 1 \cdot 10^{-5}$ MPa^{-1}, $v_0 = 2 \cdot 10^{-6}$ m/s.

Problems (3) – (5), (8) – (10), (14) – (16) with $\alpha_0 = \alpha_0^s$ re solved numerically using the finite difference method [13].

The coordinate segment $\left[0,60\right]$ is divided into 120 intervals, and the time segment $\left[0,2000\right]$ – is divided into 4000 intervals. “Measurement data” z_δ^j prepared on the basis of this decision at 200 points “time”. The results of calculations of the recovery of the coefficient α_0 with unperturbed initial data for various initial approximations are shown in Fig. 1–2.

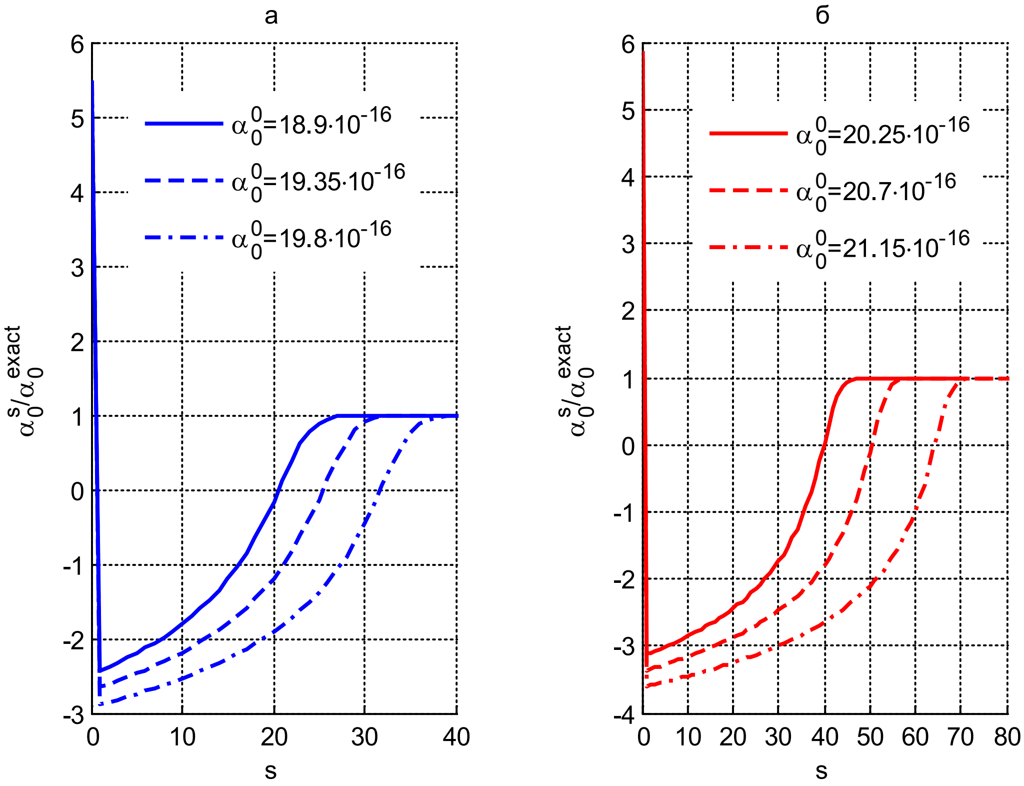

Figure 2. Recovery of the coefficient with unperturbed initial data (for $\delta = 0$), α_0^{exact} – as in Fig. 1

In the case when the initial approximation is up to three times greater (or four times less) than the exact value of the desired coefficient, 5–7 iterations are required to restore the parameter α_0 (Fig.1.a., Fig. 1.b.). In the case when the initial approximation is 3–5 times greater than the exact value of the desired coefficient, it takes 10–23 iterations to restore the parameter α_0 (Fig. 1.c., Fig. 1.d.). And in the case when the initial approximation is five to six times greater than the exact value of the desired coefficient, 28–75 iterations are required (Fig. 1.a., Fig. 1.b.). The more the initial approximation moves away from the equilibrium point, the greater the number of iterations is required.

Numerical calculations were also carried out with perturbed initial data with the initial approximation $\alpha_0^0 = 7,2 \cdot 10^{-16}$. Relative errors of coefficient recovery vary within 0.000055% to 7.912556%. The relative error in determining α_0 increases with increasing error in the initial data.

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Section 3. Food processing industry

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EFFECTIVE TECHNOLOGY FOR CLEANING MECHANICAL COMPOUNDS IN VEGETABLE OILS

Abstract. This article presents the results of research on primary purification processes of vegetable oils, i.e., data on the filtration performance of vegetable oils in a new type of filtrate called local basalt. As a result, it has been experimentally proven that there is no hygroscopicity and swelling, as well as virtually no elongation of the fibers forming a permanent porosity, thereby ensuring high filtration efficiency. As a result of primary purification of vegetable oils in the proposed filter cloth, the content of moisture and volatile substances in the main quality indicators of vegetable oils decreased from 0.20% to 0.10%, the amount of sediment in the oil from 0.05 to 0.02%.

Keywords: vegetable oils, technology for cleaning, filtration, basalt fibers.

Introduction: Industrially obtained vegetable oils consist of a mixture of fatty acids triglyceride (triacylglycerol), which is composed of a non-fat compound and oil-bearing substances [1, p. 35; 2, p. 73]. Non-fat mixtures include mechanical compounds (roasted kernels, shrot pieces, etc.), moisture, toxic chemicals, and other substances. The presence of toxic chemicals is explained by the fact that in agriculture, various toxic chemicals (pesticides, herbicides, etc.) are widely used in the fight against various pests and diseases of plants, which accumulate in the adipose tissue of the plant and are separated with oil.

During the production of vegetable oils, a purification process is carried out by distillation, centrifugation and filtration to remove coarse and mechanical impurities. It is also required after the refining (refining) process of vegetable oils, the retention of residual particles, the separation of bleaching reagent particles after the bleaching process.

One of the problems in the filtration process is that the filtration efficiency decreases as a result of the small particles in the oil blocking the filtration surface. The time and labor required to clean the filter is a factor that reduces production efficiency. Non-oily slurries in the primary purification process of vegetable oils, small particles that do not precipitate during the filtration of refined oil, and grinding of the bleaching soil to a very small size to form micropores during the bleaching process lead to rapid filling of the filter surface. The relevance of research in this area is determined by the fact that in the process of filtration can be used various agents that protect the filter surface from clogging in order to increase the life of the filter until the next cleaning and filtration efficiency.

The filtration process is an important stage in the organization of industrial production. Experts have established [2, p. 35; 2, p. 73] that the object being cleaned during mechanical filtration is divided into solid and liquid phases. In the production of vegetable oils, a purification process is carried out by distillation, centrifugation and filtration to remove coarse and mechanical impurities.

Materials and methods. The article uses modern methods of chemical, physico-chemical and other analyzes with the processing of the results by statistical methods [4, p. 107].

Vegetable oil analyzes were carried out according to the method described in the "Guidelines for research methods, technological control and production accounting in the oil and fat industry" [5, p. 22].

A method for determining the amount of moisture and light volatiles in vegetable oil

Weigh the weight of a pre-dried metal cup and add 5 g of oil to it and write the weight in the workbook. Then dry in a drying oven at a temperature of 100–105 °C for 30 minutes. After the allotted time, take the glass with a clamp, pour it into a desiccator, and after cooling, weigh it on a scale and record the result of the measurement. Then let it dry for another 15 minutes. After the allotted time, we take it out, cool it and weigh it. If there is no change between the previous and subsequent measurements, stop drying and calculate the moisture content of the oil using the following formula:

$$X = \frac{(m_1 - m_2)}{m} \cdot 100$$

where: m_1 – is the weight of the metal cup and oil before drying, g.

m_2 – weight of etal glass and oil after drying, g;

m – is the weight of the etal glass, g.

Determining the amount of crude oil precipitated

The sample of oil to be determined is weighed on a scale of 100 or 50 g of oil, depending on the amount of sediment, and placed in a 250 ml conical flask. On top of the oil sample obtained, mix three times the amount of oil with benzene. The dried filter is filtered through paper until the weight of the mixture remains constant. After the mixture is filtered, the remaining oil in the flask is washed with solvent and filtered again. The oil remaining in the filter is also washed away using a solvent. The greasy part left on the edges of the filter paper is cut, filtered and washed with solvent.

The filtrate should be clean and clear. The washed sediment is placed in a glass beaker together with filter paper and dried in a drying oven at 102–105 °C until the weight is constant, and the mass of sediment is calculated by the following formula:

$$X = \frac{(m_2 - m_1)}{m} \cdot 100$$

where: X – is the mass of sediment,%;

m_2 – is the mass of the filter paper and the dried sediment on it, g;

m – is the weight of the oil sample, g;

m_1 – is the weight of the dry glass and filter paper, g.

Results. One of the main indicators of basalt fiber material used for the production of filter materials for the purification of vegetable oils is its quality oil production. Oil permeability is the ability of a basalt material to conduct vegetable oil at a certain pressure, which is characterized by a coefficient of permeability. In this case, the oil permeability coefficient is of special importance, it is measured in $dm^3/(m^2s)$ and indicates how much.

Technical characteristics of mineral fibers and wool before and after the recommendation of the new technology are given in Table 1. This indicator is determined by calculation [6, c. 48–50; 7, C. 48]. According to the method, a stream of liquid and air was passed through each sample.

Table 1.– Specifications of mineral fiber filters

№	Technical indicators	Basalt wool rock deposits			Glass wool	Asbestos wool
		Aydarkul	Asmansay	Gavasay		
1.	Density kg/m^3	up to 23	up to 26.3	up to 24.3	70	25÷60
2.	Thermal conductivity, W/mK	0.03 ÷ 0.08	0.02 ÷ 0.06	0.02 ÷ 0.06	0.12÷0.18	0.028÷0.45
3.	Working temperature, °C	–270 ± 800	–270 ± 800	–270 ± 800	–60 ± 400	до 500 °C
4.	Fire department qualification	ISO 3941:1977 (incombustible)	ISO 3941:1977 (incombustible)	ISO 3941:1977 (incombustible)	–	–
5.	Standard tile size, m	1.4·1.2·0.5	1.4·1.2·0.5	1.4·1.2·0.5	–	–
6.	Standard roll size, m	Length: 6÷10 Width:0.2÷1.8 Length: 0.1÷0.5			–	–

From the comparative characteristics, it can be seen that the basalt fiber material of the Asmansai deposit has a filtering capacity, on average, 3.78 times higher than that of glass wool, 5.98 times higher than that of asbestos wool. In general, as a result of studying the filtering ability, the basalt fiber material showed its high efficiency and performance, which opens up broad prospects for the creation of new cheap and competitive filter materials.

The technical characteristics of the basalt fiber filter material are given in Table 2.

Table 2.– Technical characteristics of basalt fiber filter material

№	Name of indicators	Sample performance basalt fiber filter			
		I	II	III	IV
1	**2**	*3*	*4*	*5*	*6*
1.	Dimensions of the basalt filter before and after pressing: – thickness, mm – diameter, mm – area of the cross. section mm2	 10* 120 130	 10 120 13	 10 120 113	 50 120 113
2.	Humidity of basalt fiber material before filtration,%	0.3	0.3	0.3	0.3
3.	Filtration time of vegetable oil by traditional method and basalt filter, min (traditional on the numerator)	31 12	31 27	31 30	31 34
4.	Weight of samples, before wetting and after pressing and drying, g: – before: – after:	 9.3 12	 9.3 24	 9.3 17	 9.3 15
5.	Humidity and volatile substances, %	0.20	0.17	0.15	0.10

1	***2***	***3***	***4***	***5***	***6***
6.	Soap (quality analysis)	Not found			
7.	Iodine number, in g J2100 g	125–145			
8.	Non-fat compounds (sediment, by mass),%,	0.05	0.04	0.03	0.02
9.	Dry residue mass, g – traditional filtration – on basalt fiber filter**	 5 4	 5 7	 5 5	 5 4
10.	Flow pressure forces liquids, per filter, kg/mm^2	0.3	0.6	0.9	1.2
11.	Actual deflection value basalt filter, mm	1.5	3.3	5.3	5.4
12.	Forces of pressing basalt wool, kN	16	18	20	–

*Note * F: en = 1:2.74. Grade-0.074, 90%. Laboratory of Technology and Geotechnology of the Central Scientific Research Laboratory of the State Enterprise NMMC*

*** Chemical analysis of filtered oil was carried out according to “RD118.3897485.6–92”*

Discussion and Conclusion. Four basalt fabrics in the same sequence were prepared for further research. In all four samples, the geometric parameters remained unchanged. The results of experimental studies showed that the filtration time of the basalt filter in the second and third samples exceeded that of the traditional filter material in terms of vegetable oil purification performance. Such results can be achieved due to the normal filling of basalt fibers. Subsequently, natural holes are formed in the basalt fiber filter material for the free passage of the filtrate. Normal packaging is obtained by pressing the basalt fibers with a force of 16 kN. Thus, the basalt material has been proven to be suitable for industrial refining of vegetable oils.

Experimentally, the absence of hygroscopicity and swelling, as well as the fact that the elongation of the fibers forming a permanent porosity is practically absent, thus ensuring high filtration efficiency. Moisture absorption of basalt was found. However, basalts can change their properties under hydrothermal conditions, under the influence of moisture accumulated in dense rocks. Consequently, due to the density of the material, excess moisture remains inside the fabric and is retained until processing. It was also found that the content of moisture and volatile substances in vegetable oils decreased from 0.20% to 0.10%, and the content of sediment in the oil from 0.05 to 0.02%. This makes it possible to obtain quality vegetable oils and achieve high economic efficiency in oil companies.

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Section 4. Chemistry

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ANALYSIS OF THE CHEMICAL COMPOSITION AND INFRARED-SPECTROSCOPIC ANALYSIS OF SODA WASTE OF KUNGIRAT

Abstract. We know that the processing of industrial waste and its conversion into finished products is one of the most important tasks for modern chemical technologists. The article states that the IR analysis and chemical composition of Disteller liquid were studied using modern methods. At the same time, the composition was studied and a scientific conclusion was made about the negative impact on the environment. The pH analysis of the distillery liquid was studied in three parts. The composition of the distillery liquid was studied for two seasons and a scientific conclusion was made.

Keywords: Distiller liquid, Soda, pH, Infrared spectroscopy, filtration, separation, chemical composition, waste.

Introduction. At the Kungrad soda plant in the northern part of the country, the processing of waste and its conversion into finished products is an important task today. The main purpose of our research is to study the chemical composition, physical and mechanical properties of soda distillery waste and to draw scientific conclusions on all its properties in order to turn it into a usable product. Soda powder is one of the most important products of the chemical industry, used in 50% in glass production, 25% in the chemical industry, 15% in the metallurgical industry, 10% in the pulp and paper industry and other industries. Today, more than 85% of world soda production is in China, the United States, Russia, Turkey and India. In 2010–2011, the growth of soda production was 6.2%, in 2012–2013 there was a decrease in production, which was 0.59%, but in 2018–2019 the growth of production was 0.2%. and production capacity reached 51.3 million tons [1]. There are currently four main methods of soda production in the industry: ammonia (Solve method), carbonation of natural soda raw materials, nepheline, and sodium hydroxide. Despite rapid growth in the 1970s, soda production from natural soda raw materials is still one of the main methods of obtaining soda [2]. The raw material required for the production of soda by the ammonia method must be cheap, common (NaCl, $CaCO_3$). The reactions take place at low temperatures and near atmospheric pressure. The method is well studied, the technological processes are corrected and stable. The resulting soda is of high quality at a relatively low cost. While it has a number of key advantages, soda production by the ammonia method also has serious drawbacks. This is a significant consumption of energy resources and large specific capital investments required to create production. However, the main drawbacks of the Solvay method are the formation of large amounts of liquid waste, called distillation fluid, which indicates that the original natural raw material has not been used efficiently enough. Approximately 9–10 m^3 of distillation liquid is extracted from 1 ton of soda produced [3]. Currently, there is a problem of waste disposal in all countries that produce soda using this ammonia method. The new type of technology proposed for the processing of distilled liquid will prevent large-scale waste problems as well as environmental pollution. Wastewater, ie distilled liquid, is discharged into sludge reservoirs, water reservoirs located near existing production facilities. Accumulation of distillation fluid in mud ponds has a negative impact on increasing production capacity. Consequently, the elimination of waste by dumping mud ponds in a sedimentary state cannot solve the current environmental problem. Discharge of distillation fluid leads to the inevitable mineralization of natural reservoirs, significant changes in the biological state of water bodies. As a result, reservoir pollution can directly or indirectly affect humans, harming the interests of industrial water supply. The main task of improving the environmental safety of soda production is to develop a method of processing distilled liquid and return the treated water to the recycling process. Thus, the scientific and technical task is to recycle the main wastes of soda production with the increase in production volume [4]. It is of scientific and practical interest to convert distilled liquids from the wastewater of soda factories from recycled waste for the production of other types of products for poultry, fisheries and livestock into calcium and magnesium salts by converting them into carbonate and phosphate salts. The project capacity of the Kungrad soda plant is 100.000 tons per year.

Object and method. IR analysis and chemical composition of distiller liquid are studied by modern methods. At the same time, the composition was studied and a scientific conclusion was made about the negative impact on the environment. The pH analysis of the distillery liquid was studied in three parts. The composition of the distillery liquid was studied for two seasons and a scientific conclusion was made. For the study, we used Japanese IR-Fourier spectrometer, Shimadzu IRAffinity-1, high-efficiency energy-dispersed X-ray fluorescent spectrometer – Japan, Rigaku NEX CG EDXRF and Kungirad soda Distiller liquid (filtrate), Kungirad soda distillate liquid sediment, Kungirad soil soaked in distillate liquid.

Table 1. – Quantitative analysis of distiller liquid

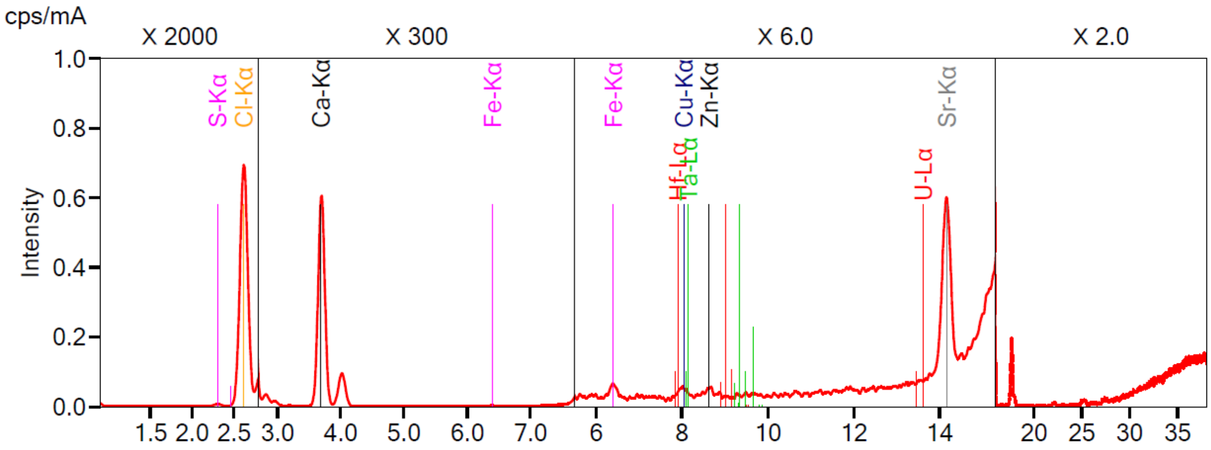
№		The result obtained
1.	General alkalinity	0.6 mg* ekv/dm^3
2.	General salinity	1605.53 mg/dm^3
3.	Solids	1.5 mg/dm^3
4.	Hydrogen indicator	12.04
5.	Temperature	21°S

№	Mass concentration of components	The result obtained
1.	Calcium (Ca^{2+})	3.0 mg* ekv/dm^3
2.	Magnesium (Mg^{2+})	Not available
3.	Sodium (Na^+)	485.07 mg/dm^3
4.	Iron (Fe^{2+})	0.10 mg/dm^3
5.	Sulfates (SO_4^{2-})	662.81 mg/dm^3
6.	Chlorides (Cl^-)	366.15 mg/dm^3

Table 2. – Elemental analysis of distiller liquid: (from dispersed X-ray fluorescent spectrometry – Japan, Rigaku NEX CG EDXRF)

№	**Components**	**Chemical composition**							
		Cl	**SO_3**	**K_2O**	**CaO**	**MnO**	**Fe_2O_3**	**CuO**	**ZnO**
1.	Distiller liquid (filtrate) mg/cm^2	90300	4260	–	55600	–	36.6	6.48	6.01
2.	Kungirad precipitation of soda distillation liquid	36.8	4.40	0.0317	32.5	0.0182	0.0969	0.0084	0.0013
3.	Kungirad soil moistened with distilled liquid	2.03	0.830	0.0327	59.5	0.0149	0.154	0.0020	0.0019

№	**Components**	**Chemical composition**						
		Rb_2O	**SrO**	**Ag_2O**	**SiO_2**	**TiO_2**	**MgO**	**V_2O_5**
1.	Distiller liquid (filtrate) mg/cm^2	–	19.3	0.0013	–	–	–	–
2.	Kungirad precipitation of soda distillation liquid	0.0005	0.0168	0.0012	–	–	–	0.0019
3.	Kungirad soil moistened with distilled liquid	–	0.0155	–	0.686	0.0139	0.944	0.0029



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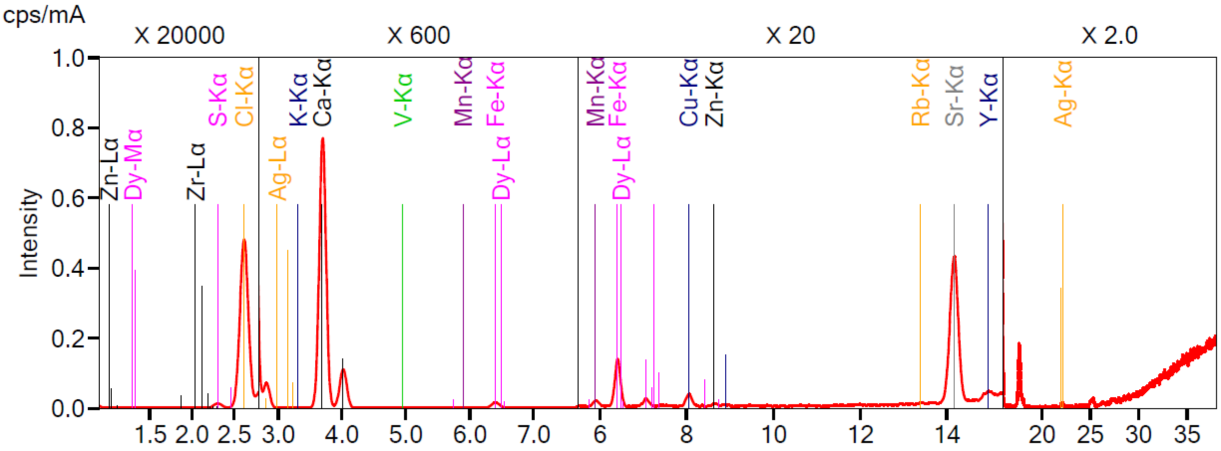

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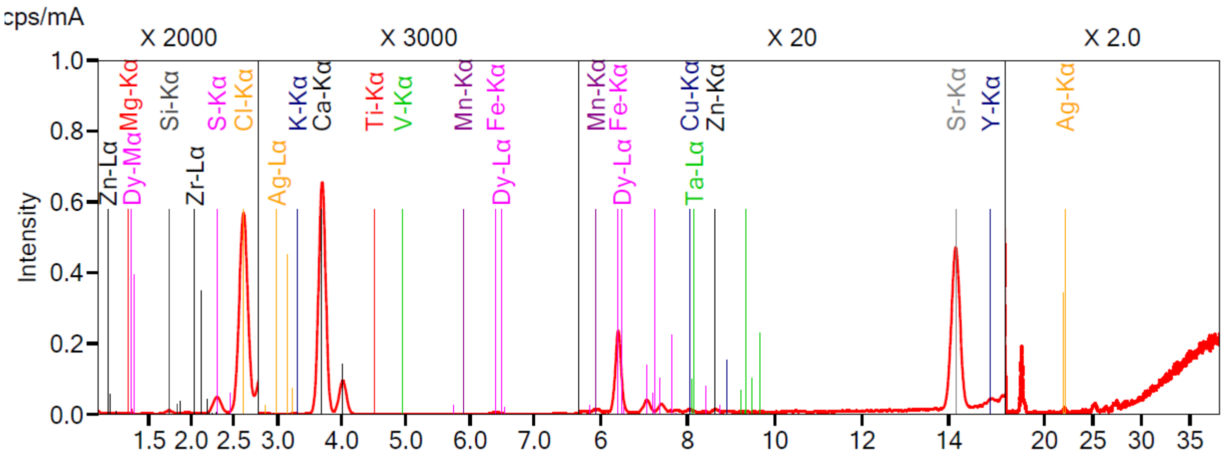

C

Figure 1. Element analysis: A – Distiller liquid (filtrate); B – Kungirad precipitation of soda distillation liquid; C – Kungirad soil moistened with distilled liquid

From the analysis of elemental analysis it can be seen (Table 1 and Figure 1), when the soda plant wastewater is studied in two parts (liquid and sediment): the liquid part contains Cl^-, Ca^{+2}, Fe^{+3}, We can observe a large amount of SO_4^{2-} ions and Cl^-, Ca^{+2} ions in the sediment. Along with the study of distillery liquid, when studying the chemical composition of the soil of the waste liquid discharge, it is possible to see a strong rate of salinity in the ground due to the abundance of Ca^{+2} ions, pH = 12.04. This has a negative impact on the agrochemical properties of the soil. The reduction of microorganisms in the soil leads to an increase in the hygroscopicity of the soil where the liquid is discharged

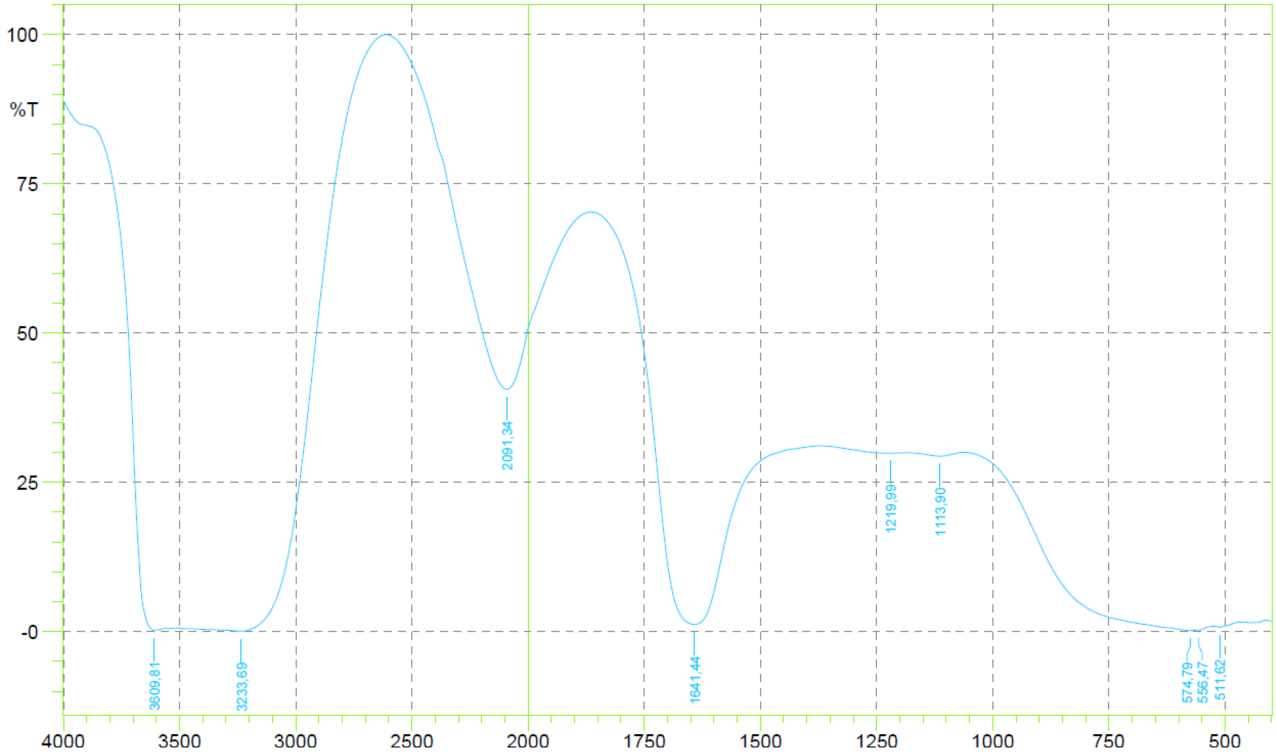

Figure 2. In the IR spectroscopic analysis of the filtrate part of the Disteller liquid, OH-ions in the 3609.81cm^{-1} area, NH bonds in the 3233.88cm^{-1} area, Ca^{+2} ion in the 1210cm^{-1} area, Fe in the 1113.90cm^{-1} area $^{+3}$ ions and sulfate ions can be observed in the area of 574.7–511.62 cm^{-1}

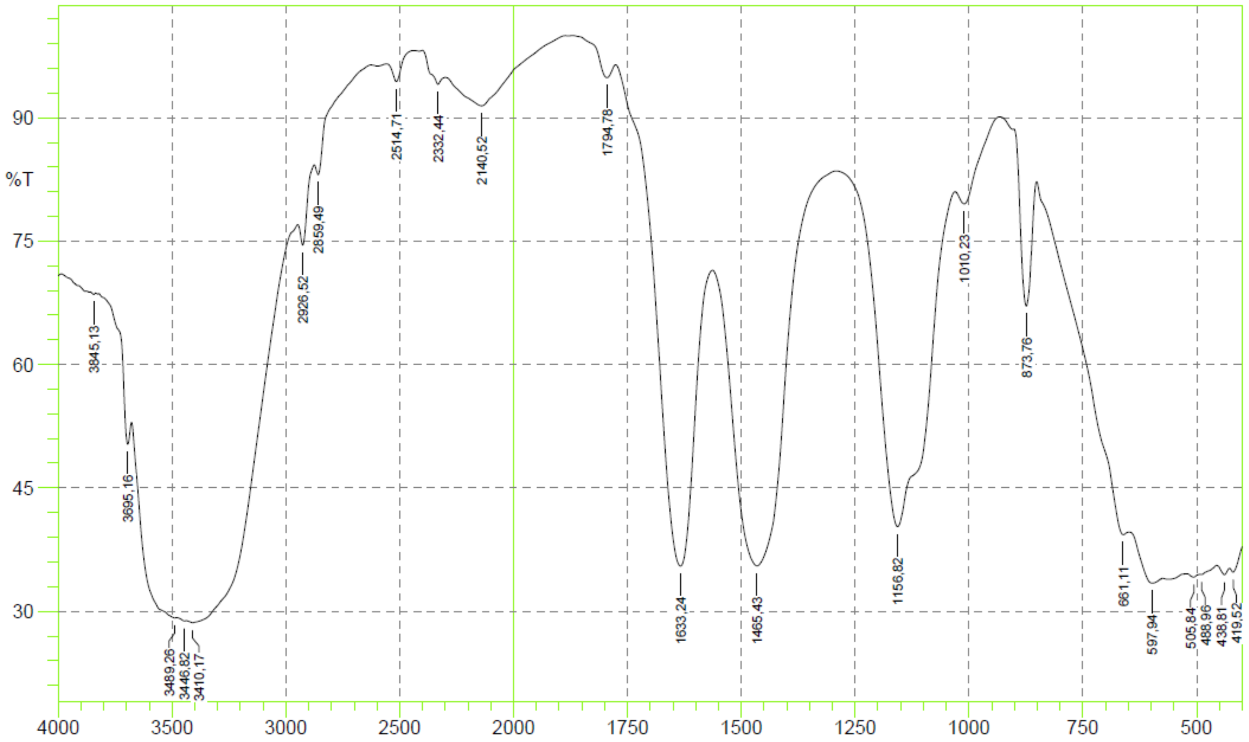

Figure 3. In the IR spectroscopic analysis of the sedimentary part of the distiller liquid, OH^- ions in the area 3489.26–3410,17 cm^{-1}, Cl – ions in the area 2926.52cm^{-1}, Ca^{+2} ion in the area 1010.23cm^{-1} and 419, The AgCl molecule can be observed in the area of 52 cm^{-1}

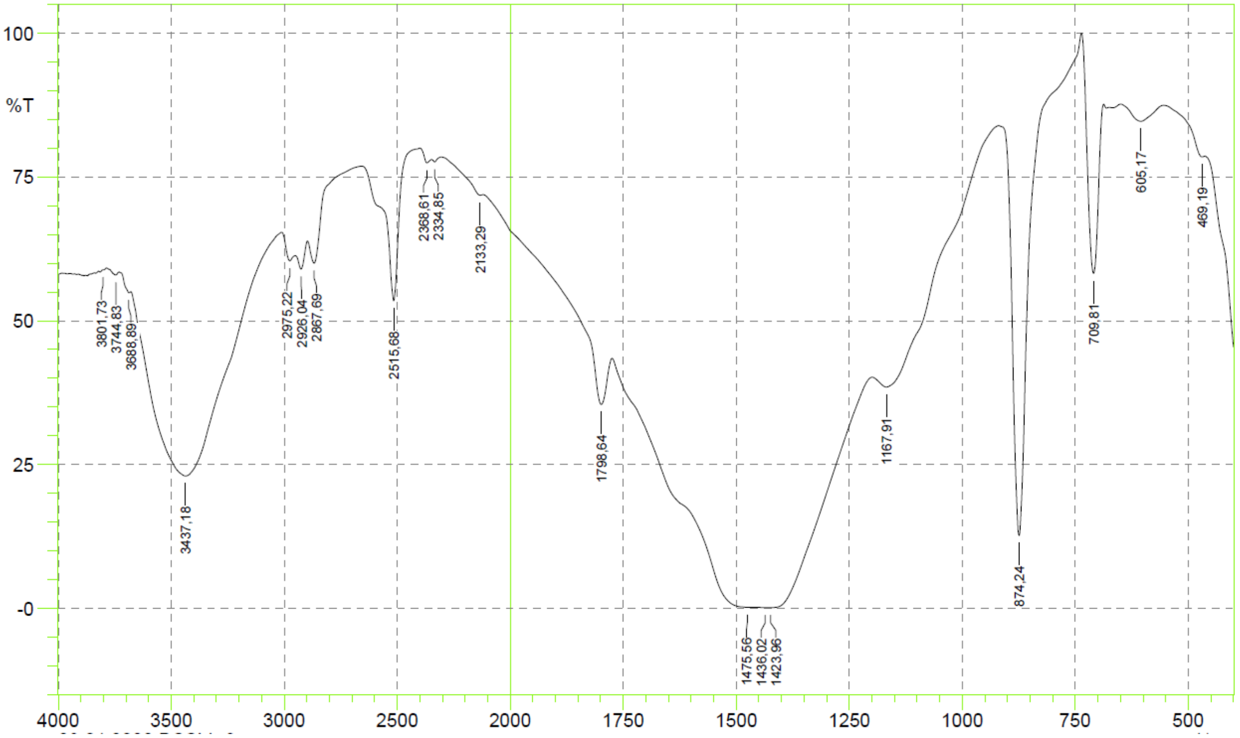

Figure 4. Analysis of infrared spectroscopic analysis: A – Distiller liquid (filtrate); B – Kungirad precipitation of soda distillation liquid; C – Kungirad soil moistened with distilled liquid

Conclusion. The composition of the distillery liquid was studied for two seasons. As a result of the study, the following scientific conclusions were made: The purpose of recycling soda plant waste is to maintain the ecological condition of the plant area in a positive state. Exploring the chemical basis of wastewater by proposing methods of recycling the finished product state.

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SYNTHESIS OF 4-HYDROXIBENZOIC ACID DERIVATIVES WITH AMINO ACIDS AND THEIR POTENTIAL PHARMACOLOGICAL PROPERTIES

Abstract. Derivatives of 4-hydroxybenzoic acid with glycine and 4-aminobutanoic acid have been synthesized. To increase the solubility of substances, salts with potassium were poured. It is shown that the synthesized substances have biological activity. Synthesized substances were studied using computer programs Gausview, Passonline, which showed the activity of molecules and biological activity. Experiments will be conducted to confirm the activity.

Keywords: 4-hydroxybenzoic acid, glycine, 4-aminobutanoic acid, salt, synthesis, biological activity.

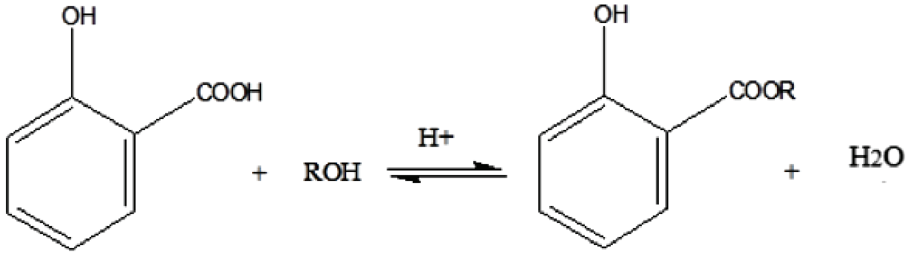
Introduction

Today, the synthesis of drugs is one of the current problems of chemistry. Since the middle of the 19th century, salicylic acid (SA) has been isolated from salicin. Aspirin was developed and patented by Bayer specialists during the synthesis of its compounds in order to study the biologically active properties of SA. Although aspirin was synthesized and used for over 150 years, it is still used as one of the most widely used pharmacological drugs in the world. Acetylsalicylic acid (ASA) has specific biological properties (anti-inflammatory, antipyretic, antithrombotic, analgesic). In the body ASA inhibits cyclooxygenase and irreversibly inhibits the metabolic pathway of cyclooxygenase (COX-1 and COX-2) of arachidonic acid, i.e. it stops the synthesis of several prostaglandins [1]. Usually the origin of the term aspirin is associated with hyperthermic properties, from the ancient Greek "pyro" – fire. However, there is another idea, namely, that salicylic acid was first isolated by C. Lovig from a plant called Spirae Ulmaria. In this case, the letter "a" (acylation) was added before the word "spir" and then the suffix "in" was added to make it sound better [2]. According to recent data, SA products are synthesized in the body and act as a bioregulator and have a protective function, which, in turn, means that the role of SA in human and animal pathophysiology should be reviewed [3; 4].

In this regard, one of the urgent tasks is the synthesis of new substances and their derivatives based on oxybenzoic acids, creation of new methods of synthesis and development of existing ones. It is also important to target therapeutic agents based on oxybenzoic acids with low toxic properties and high biologically active properties.

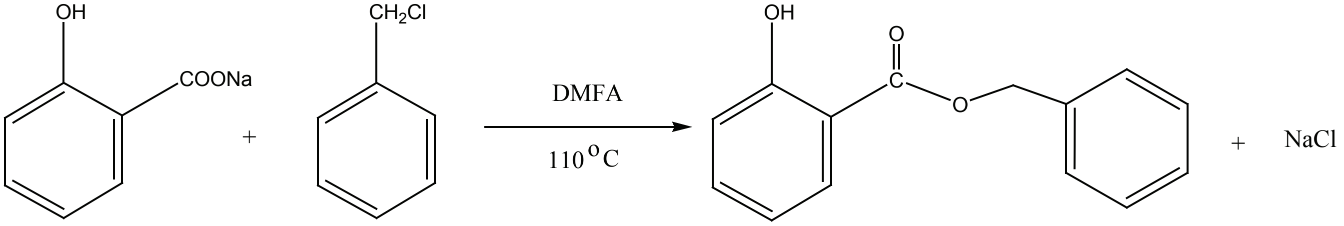
Materials and Methods

It is known that SA derivatives are obtained by different methods, one of which is the production of esters, i.e., alkyl ethers, carried out in the presence of catalytic sulfuric acid with the corresponding alcohols:



The duration of the esterification reaction according to the classical method is 5–12 hours, and the yield of the reaction is from 55% to 80%, depending on the ortho-, meta-, and para-states of the -OH and -COOH groups, as well as the molecular weight of the alcohol [5; 6].

However, another way to obtain esters is the application of silver and sodium salts to halogen derivatives, for example, the interaction of sodium salicylate and benzyl chloride produces benzylsalicylate. In this reaction dimethylformamide 110^{0}C the yield was 79% when conducted in the environment [7; 8].

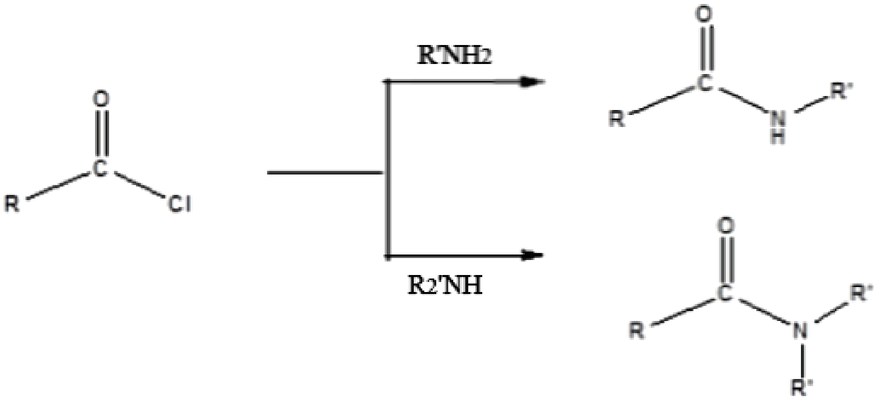


SA amides and its derivatives has a variety of pharmacological activities: antipyretic, sedative, anti-vibration, and high diaphoretic activity [7; 8].

Therefore, intermediate derivatives of SA are very important because they facilitate the synthesis of substances of a given composition. In our opinion, carbonic acid chlorohydride is an intermediate for the synthesis of the corresponding amides because it forms an amide corresponding to ammonia. The reaction requires a lot of ammonia and additionally hydrochloric acid. In general, the reaction scheme can be written as follows:

$$RC(O)Cl + 2NH_3 \rightarrow RC(O)NH_2 + NH_4Cl$$

However, amides are also obtained by the interaction of amines with chlorohydrides in the following reaction:

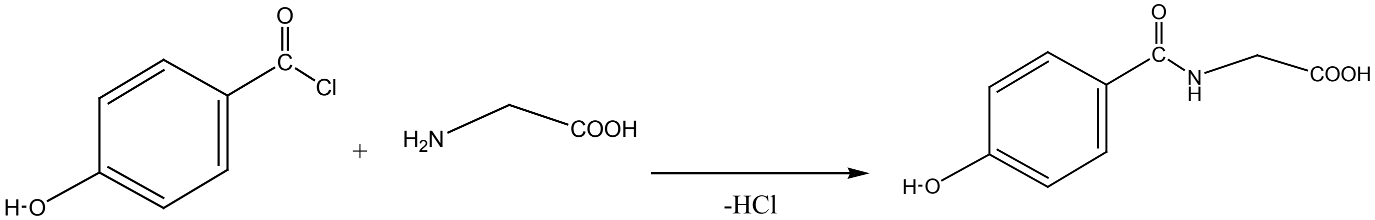


Synthesis of preservative derivatives of SA nitrogen compounds is a promising area of search for new effective and non-toxic long-acting drugs. The role of amino acids in the body is very broad; complex substances such as amino acids, peptides and proteins are structural components of enzymes, coenzymes, hormones and receptors [9; 10]. Amine derivatives exhibit a variety of biological activities, including psychotropic, analgesic, anti-inflammatory and others. Today in practice there is increasing interest in γ-aminobutyric acid (GABA) and its derivatives, many drugs based on GABA have neuroprotective activity [11; 12].

Therefore, the synthesis of hydroxybenzoic acid derivatives with amino acids is relevant. For this purpose, a 4-hydroxybenzoic acid-based SA derivative was synthesized and their potassium salts were obtained to increase the water solubility of the synthesized substance.

Synthesis of N-(4-hydroxybenzoyl)glycine

The obtained 4-hydroxybenzoyl chloride is introduced dropwise for 1.5–2 h with a glycine solution (5.00 g g glycine in 28.30 ml water). The mixture is cooled, then stirred for another 1.5 hours, keeping the pH > 7. The resulting mixture is poured on ice. Hydrochloric acid is added to pH = 5. The resulting precipitate is filtered and dried. The yield is 76%. Tm = 220–223 °C.



Synthesis of N-(4-acetoxybenzoyl)glycine

A stirrer, reflux condenser and thermometer are placed in a three-neck flask.10.00 g (72.40 mmol) of 4-oxybenzoylglycine, 25.00 ml of acetic acid and 0.20 ml of sulfuric acid. To the 6.8 mL mixture was added (72.40 mmol) acetic anhydride and stirred at 45 °C for 2 hours. The precipitated crystals are recrystallized with isopropanol, filtered and dried. The yield is 73%. Tm = 194–197 °C.

Synthesis of 4-[(N-4-acetoxybenzoyl)amino] butanoic acid

N-(4-acetoxybenzoyl) is obtained as glycine. The yield of the reaction is 76%. Tm = 195–197 °C.

Potassium salt of N-(4-acetoxybenzoyl)glycine

4.6 g (100 mmol) of potassium ethylate (potassium metal treated with absolute ethanol), 100.00 g of benzene and 2.70 g (100 mmol) of N-(4-acetoxybenzoyl)glycine in a three-neck flask with stirrer, reverse cooler and thermometer are added. The mixture in the flask is stirred at 100 °C for 30 minutes. After cooling the mixture is filtered, washed with a slightly alkaline alcohol solution and dried. The resulting substance is a white crystal. The yield is 72%. Tm = 203–205 °C.

Potassium salt of 4- [N-(4-acetoxybenzoyl) amino]butanoic acid

The yield of the reaction is 78%. Tm = 235 – – 237 °C.

Conclusion

Some quantum-chemical properties of substances were studied. The results of the studies show complex interactions of functional groups in the molecules of substances. Based on the structure of the obtained substances, it can be concluded that they can form complex compounds. The structure of the obtained 4-hydroxybenzoic acid derivatives was confirmed by IR, H^1NMR, C^{13}NMR spectroscopy, the physical and chemical properties of compounds were studied [13; 14]. The PASS Online program was used to predict the biological activity of the synthesized substances. From the prediction follows the need for preclinical studies to confirm the pharmacological properties of the substances obtained [15; 16].

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