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ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
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Д.В. Сокольский атындағы «Жанармай,
катализ және электрохимия институты» АҚ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
АО «Институт топлива, катализа и
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NEWS

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NAS RK is pleased to announce that News of NAS RK. Series of chemistry and technologies scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Химия және технология сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия химии и технологий» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

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**FLAVONOIDS OF *POPULUS BALSAMIFERA* PLANTS
AND THEIR BIOLOGICAL ACTIVITY**

Abstract. The work is devoted to the chemical studying of the composition of flavonoids of *Populus balsamifera*, the isolation of individual compounds, and the establishment of their structure. Balsamic poplar plants are a promising source of many biologically active substances, and in particular, flavonoids. From the buds of *Populus balsamifera* L. identified four flavonoids with antifungal, antimicrobial antioxidant properties and hepatoprotective activity. Data of flavonoids were isolated by extraction on the soxlet apparatus with 95% ethanol by triple thermal extraction at a temperature of 60 °C, followed by thickening on a rotary evaporator. For isolation from the buds of balsamic poplar, the resulting extract was chromatographed on a column with silica gel of the KSK brand 0.31-0.63 microns, using petroleum ether as eluents petroleum ether-ethyl acetate in various ratios and ethyl acetate. The structure of the isolated compounds was determined by IR, UV, NMR ¹³C, ¹H spectroscopy. The biological activity of the isolated flavonoids was also studied.

Key words: the poplars, flavonoids, extraction, biological activity.

Introduction. Plants of the genera *Populus* attract the attention of researchers as a source of valuable biologically active substances, primarily flavonoids [1].

Flavonoids are the most extensive group of phenolic compounds and important component of the plant body. They take an active part in redox processes, developing immunity, protecting plants from the adverse effects of UV rays and low temperatures. Some of them are interacting with ascorbate oxidase, protect ascorbic acid from oxidation.

Most flavonoids have a capillary-strengthening effect on the human and animal bodies and reduce the permeability of hematopoietic barriers [2]. This action is the basis of the pharmacological, preventive and therapeutic effects of these compounds (anti-inflammatory, anti-radiation, sensitizing, antitumor effects, etc.).

The relevance of research on flavonoids is due to the need for health care and the pharmaceutical industry of the Republic of Kazakhstan in new and effective medicines from plant origin.

The study of the chemical composition of wild and cultivated medicinal plants is all the more relevant, since Kazakhstan has the richest reserves of plant resources, and only a small part of them is used in practical medicine.

Thus, the aim of the work is to study the chemical composition of flavonoids of plants *Populus balsamifera* L., to isolate individual compounds, to establish their structure and to study their biological activity.

The object of research in this work is *Populus balsamifera* L. (poplar balsamic), which grows in the nature of Kazakhstan.

To isolate flavonoids, vegetable oil is extracted with lower alcohols. Alcohol extraction evaporate dilute hot water and after cooling remove non-polar compounds (porophylls essential oils, carotenoids) from the water or four carbon. Flavonoids from the aqueous phase are sequentially extracted with diethyl

ether (aglycones), ethyl acetate (monosides) and butanol (biocide) [3]. It should be known that such compounds are extracted by nature coumarins and phenolic acids.

Silica gel, cellulose powder are used as sorbents for column but the bowl is used more often.

Experimental Part. Crushed air-dry poplar buds were extracted on a "Sokslet" apparatus with 95% ethanol by the method of triple thermal extraction at a temperature of 60 °C, followed by concentration on a rotary evaporator. As it is demonstrated on figure, balsamic poplar belongs to the class of the Dicotyledons - Dycotyledoneae, family of Willows - Salicaceae and the Poplar genus - Populus L.

The tree reaches a height of 25-30 m and a diameter of up to 1 metr high.

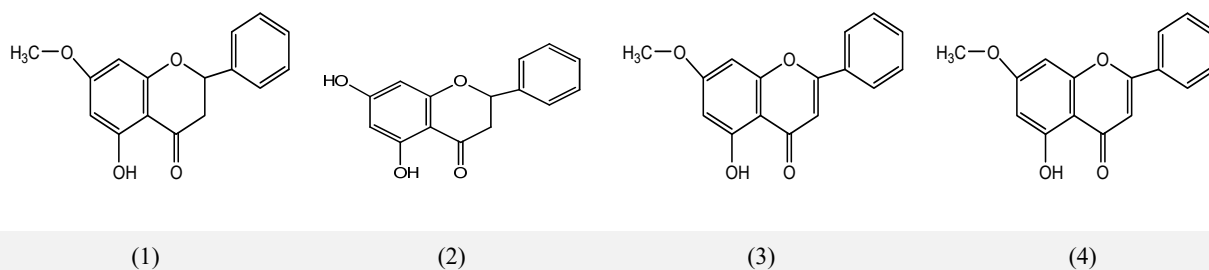
Shoots are grayish-green or brownish-brown, cylindrical, sticky, fragrant, resinous, sometimes slightly angular near the buds.



Buds of balsam poplar

Buds are greenish-brown or brown, large, 12-15 mm long, terminal - 18-23 mm, highly sticky, aromatic. The lateral buds are cone-shaped, pressed, somewhat deflected sideways, very sticky and aromatic. The core is yellowish, loose; the wood is greenish.

For isolation from the buds of balsamic poplar, the resulting extract was chromatographed on a column with silica gel of the KSK brand 0.31-0.63 microns, using petroleum ether as eluents petroleum ether-ethyl acetate in various ratios and ethyl acetate [4,5]. The control was performed using thin-layer chromatography method in the petroleum ether - ethyl acetate system at a ratio of 4:2, and as a developer was chosen 3 % solution of FeCl₃. With the help of a flash chromatograph, were isolated individual compounds such as: pinostrobin (1), pinocembrin (2), tectochrysin (3) and chrysin (4).



Fractions identical in composition were pooled and recrystallized [6,7]. The mixture was further chromatographed on a column at a ratio of the mass chromatographed fraction to the adsorbent of 1:20.

The first 12 fractions contain colorless and from 13 to 19 yellow oily components, which turned out to be essential oils.

The control was carried out by the method of thin layer chromatography (TLC) in the petroleum ether - ethyl acetate system at a ratio of 4: 2, and a 3% FeCl₃ solution was chosen as the developer.

Flavonoids were not found in fractions 13 to 19.

In fractions 20-25 the fraction was exposed oily pinostrobin. Compound fractions were washed by petroleum ether and as result we got pure pinostrobin.

In fractions 26-59 was found out pure pinostrobin

From the 60 - 66 fractions we got mixture of pinostrobin and tectochrysin which was combined into one fraction and re-applied.

Clean fractions in which only the developer is (according to chromatography with a 3% solution FeCl₃) - 67-92 (tectochrysin), 102-117 (pinocembrine), 122-150 (chrysin).

The remaining of fractions where the mixture of the two forms were combined in a column for repeated chromatography.

Structure of isolated compounds (1,2,3,4) was established by IR, UV, NMR.

Also there was allocated four flavonoid substances ototoxic to flavanones (petromin pinocembrin) and flavones (chrysin and tectochrysin).

Result and discussion. Biological activity of flavonoids of Populus balsamifera L. Analysis of the experiment of hepatoprotective activity indicates that all the presented samples of flavonoids (pinostrobin, pinocembrine, tectochrysin, chrysin) have a different degree of positive effect on the course of experimental hepatitis.

In dynamics, ALT and AST activity decreased in all three experimental groups, which are indicators of the severity of cytolysis syndrome. According to the analysis, the most active inhibitor of hepatocyte cytolysis is pinostrobin [8].

The level of cholesterol, which is an indicator of cholestasis syndrome, in all experimental groups progressively decreased throughout the experiment.

The level of total protein in the groups receiving the compound - pinostrobin was normalized by day 21, which indicates normalization of protein-synthetic liver function.

Conclusions. Thus, according to the results of tests for hepatoprotective activity, the presented samples of flavonoids of balsamic poplar buds have hepatoprotective activity, while the most pronounced cytolytic activity is possessed by pinostrobin.

Secondly, all these samples have a normalizing effect on the synthesis of proteins in the liver and prevent the phenomenon of cholestasis.

Thus, four flavonoids were isolated and identified from the buds of balsamic poplar: pinostrobin, tectochrysin, pinocembrin, and chrysin.

According to the results of biological activity, the isolated flavonoids-pinostrobin, pinocembrine, tectochrysin, chrysin have hepatoprotective activity. According to the results of tests for hepatoprotective activity, the most pronounced flavonoid was pinostrobin.

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POPULUS BALSAMIFERA ӨСІМДІГІНІҢ ФЛАВОНОИДТАРЫ ЖӘНЕ БИОЛОГИЯЛЫҚ БЕЛСЕНДІЛІГІ

Аннотация. Жұмыс *Populus balsamifera* L. өсімдіктерінің флавоноидтарының құрамын химиялық зерттеуге, жеке қосылыстардың бөлінуіне және олардың құрылымын анықтауға арналған. Бальзамды терек өсімдігі көптеген биологиялық белсенді заттардың, атап айтқанда, флавоноидтардың перспективалық көзі болып саналады. *Populus balsamifera* L бүршігінен антифунгальді, микробқа қарсы, антиоксидантты және гепатопротекторлық белсенділігі бар төрт флавоноид бөлініп алынды. Әдетте флавоноидтарды бөліп алу үшін өсімдік шикізаты төменгі спирттермен экстракцияланады. Бұл флавоноидтар «Соклет» аппаратында 95% этанолмен экстракция әдісімен 60°C температурада үш рет термиялық экстракция әдісімен оқшауланған, содан кейін айналмалы буландырғышта концентрацияланған. Бальзамды терек бүршігінен алынған сығындыны бөліп алу үшін элюенттер ретінде петролей эфири, петролей эфир-этилацетаты мен этилацетат пайдалана отырып, КСК 0.31-0.63 мкм маркалы силикагель негізінде бағаналы хроматография әдісі қолданылды. Бөлінген қосылыстар құрылымы ИК -, УК -, ЯМР ¹H, ¹³C спектроскопия әдістері арқылы анықталды. Сонымен қатар бөлінген флавоноидтардың биологиялық белсенділігі зерттелді.

Түйін сөздер: бальзамикалық терек, флавоноидтар, экстракция, биологиялық белсенділік

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ФЛАВОНОИДЫ РАСТЕНИЙ *POPULUS BALSAMIFERA* И ИХ БИОЛОГИЧЕСКАЯ АКТИВНОСТЬ

Аннотация. Работа посвящена химическому изучению состава флавоноидов растений *Populus balsamifera* L., выделению индивидуальных соединений, установлению их строения. Растения тополя бальзамического являются перспективным источником многих биологически активных веществ и, в частности флавоноидов. Из почек *Populus balsamifera* L. выделено четыре флавоноида, обладающих противогрибковой, антимикробной, антиоксидантной, гепатопротекторной активностью. Для выделения флавоноидов проводят экстракцию растительного сырья, как правило, низшими спиртами. Данные флавоноиды были выделены методом экстракций на аппарате “Сокслет” 95%-ным этанолом методом трехкратной термической экстракции при температуре 60 °С последующим сгущением на роторном испарителе. Для выделения из почек тополя бальзамического полученный экстракт хроматографировали на колонке с силикагелем марки КСК 0.31-0.63 мкм, используя в качестве элюентов: петролейный эфир, петролейный эфир-этилацетат в различных соотношениях и этилацетат. Строение выделенных нами соединений установлено методами ИК-, УФ-, ЯМР ¹H, ¹³C спектроскопии. Также была изучена биологическая активность выделенных флавоноидов.

Ключевые слова: тополь бальзамический, флавоноиды, экстракция, биологическая активность.

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