

GROWTH PROMOTING ACTIVITY OF FLAVONOIDS OF EXTRACTS OF POPULUS BALSAMIFERA BUDS

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Abstract. *Introduction.* Currently, the urgent task is to accelerate the development of alternative plant protection measures, which is associated with the aggravation of the environmental situation, the desire to reduce pollution of agricultural landscapes and obtain agricultural products with minimal use of agrochemicals. Poplar extract is a plant growth stimulant due to the presence in its composition of saturated and unsaturated fatty acids, lipids, phenolic and polyphenolic compounds, amino acids, essential oils, vitamins, which provide a stable growth-stimulating effect. The advantages of biological preparations, based on balsamic poplar, include their low cost, the absence of a negative effect on plant productivity, high specificity, low toxicity. The main difference between biological preparations and other plant protection products is that they are able to stimulate the natural protective abilities of the plants themselves, thereby affecting harmful organisms. The use of such drugs is one of the ways to solve environmental problems in agriculture and a powerful means of increasing the effectiveness of both plant protection from phytopathogens and crop production in general. *The purpose* is to evaluate the stimulating activity of the extracts of the buds of poplar balsamic *Populusbalsamifera* on the seed productivity of flax. *The objectives:* to isolate the sum of flavonoids from balsamic poplar; to establish the growth-stimulating activity of the extract of the buds of balsamic poplar in relation to flax seeds. *Methodology.* The method of obtaining the proposed balsamic poplar extract includes the use of balsamic poplar buds, air drying, grinding, extraction with 90% ethanol in a Soxlet apparatus, filtration and evaporation until the target product is obtained. *The results.* The obtained results and conclusions. In the course of the study, flavonoids have been isolated from the buds of balsamic poplar. The presence of flavonoids in the ethanol extract is confirmed by qualitative reactions. The composition of poplar kidney extract has been investigated by thin-layer chromatography. *Conclusion.* It has been found that the extract from the poplar buds mainly contains substances of a flavonoid nature. The results of studying the growth-stimulating activity of the extracts of balsamic poplar *Populusbalsamifera* showed high seed productivity of flax of Tomsk selection in the control group; reproduction conditions have positively affected the yield of flax.

Key words: flavonoids, *Populusbalsamifera*, growth-stimulating activity, flax seeds, extract

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Citation: Meshchanova A.G., Polyakov V.V. Growth promoting activity of flavonoids of extracts of populus *balsamifera* bud's. *Chem. J. Kaz.*, **2023**, 2(82), 152-161. DOI: <https://doi.org/10.51580/2023-2.2710-1185.22>

1. Introduction

More than 5 thousand species of plants grow in Kazakhstan, in the North Kazakhstan region - more than a thousand species of 95 families of higher plants [1]. The balsam poplar (*Populusbalsamifera*) has been chosen as the object of study due to its wide distribution and availability in the territory of Northern Kazakhstan.

Poplars, numbering more than 15 species in Kazakhstan, are interesting in their diversity, reserves and possibilities for practical use. The buds are ovoid objects with a pointed apex, sticky reddish-brown, 1.5-2 cm long and 0.6-0.8 cm thick. Balsam poplar grows everywhere in the Northern Kazakhstan [2-3]. A poplar extract is a plant growth stimulant due to the presence in its composition of saturated and unsaturated fatty acids, lipids, phenolic and polyphenolic compounds, amino acids, essential oils, vitamins, which provide a stable growth-stimulating effect [4]. In the current situation, the use of physiologically active substances (PAS) deserves special attention: growth regulators, vitamins, humic substances, antibiotics, organic acids, microelements, etc. Physiologically active substances in small doses improve nutrition, increase crop yields, and improve the quality of the products obtained [5].

The advantages of biological preparations based on balsam poplar include their low cost, the absence of a negative effect on plant productivity, high specificity, and low toxicity. The main difference between biological preparations and other plant protection products is that they are able to stimulate the natural protective abilities of the plants themselves, thereby affecting harmful organisms. The use of such preparations is one of the ways to solve environmental problems in agriculture and a powerful tool for increasing the efficiency of both plant protection against phytopathogens and crop production in general [6]. In the buds of balsamic poplars growing in the Northern Kazakhstan, the presence of such compounds as pinostrobin, pinocembrin, chrysin, tectochrysin has been observed in the composition of polyphenols. apigenin, kaempferol, quercetin, myricetin, galangin, isalpinin, isorhamnetin, rhamnetin, 2,6-dihydroxy-4'-methoxychalcone and 4',6'-dihydroxychalcone. Poplar buds also contain protocatechuic, gallic, transcinamic, p-coumaric, ferulic, and caffeic acids [7].

The aim of the study has been to evaluate the stimulating activity of balsam poplar bud extracts on the seed productivity of flax.

Tasks:

1. Select the amount of flavonoids from balsam poplar.
2. To establish the growth-stimulating activity of the balsamic poplar bud extract in relation to flax seeds.

1. Experimental part

The isolation of the amount of flavonoids from the plant materials. Based on the results of a qualitative analysis of the main groups of biologically active

substances, the selection of the optimal extractant was carried out, with the help of which it seems possible to determine the entire complex of compounds in the plant materials. The solvent must meet the following requirements: to extract the active substances from the raw materials to the maximum extent, to be affordable for the production from an economic point of view, to wet the plant material well for free penetration through cell membranes. Ethyl alcohol was chosen as the solvent due to its environmental friendliness, good preservative capacity and low boiling point. The method for obtaining the proposed balsamic poplar extract with growth-stimulating activity includes the use of balsam poplar buds, air drying, grinding, extraction with 90% ethanol in a Soxhlet apparatus for 24 hours, filtration and evaporation to obtain the target product [8-9].

Identification of flavonoids in the obtained extracts. Identification of flavonoids was carried out using the method of thin layer chromatography and color reactions with 2% aluminum chloride, Synod's test, Briant's test, 1% lead acetate solution, 10% sodium hydroxide solution.

To conduct a qualitative analysis, a 5 g sample of dry raw materials, crushed to 1-2 mm, was poured with 90% ethyl alcohol to 50 ml and boiled in a water bath under reflux for 2 hours.

Quantitative determination of the amount of flavonoids in plant materials.

To quantitatively determine the content of flavonoids in the balsamic poplar extract, the reaction of complex formation of flavonoids with aluminum chloride in a slightly acidic medium by spectrophotometry was used, since this reaction gave the most stable results. To do this, the raw material was crushed by crushing to 0.4-2 mm, then a sample of 1 g of the crushed raw material was placed in a flask with a thin section, 30 ml of 90% ethanol containing 1% concentrated hydrochloric acid was added, and heated in a water bath for 30 minutes with reverse refrigerator. Cooling was carried out under running cold water to a temperature of 20 degrees. The contents of the flask were filtered through a paper filter into a volumetric flask with a capacity of 150 ml. The above process was repeated two more times, the combined extracts were filtered into the same volumetric flask, the volume of the filtrate was adjusted to 150 mm with 90% ethanol (solution A).

2 ml of solution A was placed in a volumetric flask with a capacity of 25 ml, 1 ml of a 1% solution of aluminum chloride in 95% ethanol was added and the volume of the solution was adjusted to 25 ml with 95% ethanol; after 20 minutes, the optical density of the solution was determined on a spectrophotometer at a wavelength of 430 nm in a 10 mm cuvette. The reference solution was prepared as follows: 2 ml of solution A was placed in a 25 ml volumetric flask and the volume of the solution was brought to the mark with 95% ethanol.

The content of the sum of flavonoids in terms of quercetin and absolutely dry raw materials was determined by the formula:

$$X = \frac{D \cdot 100 \cdot 100 \cdot 100 \cdot 25}{764,6 \cdot m \cdot 2 \cdot (100 - w)},$$

where D is the density of the test solution; 764.6 - specific absorption index of the complex of quercetin with aluminum chloride at 430 nm; m is the mass of raw materials in grams; w - weight loss during drying of raw materials in%.

Evaluation of the effectiveness of the balsam poplar bud extract on the seed productivity of northern flax. The buds were crushed to a size of 0.4-2 mm, ground to a homogeneous mass, extracted with ethanol for 24 hours when heated in a water bath at 60 degrees. The extracts were then filtered through two layers of cloth. Flax seeds (50 pieces each) were germinated in Petri dishes in 0.5% solutions of the studied extracts in the light at 20–22°C for 20–24 hours. Distilled water was used as a control. The count of germinated seeds in the experiment was carried out after reaching a 50% level of seed germination in the control, using a 3-fold repetition.

2. Results and discussion

The composition of the extract of poplar buds has been studied by thin layer chromatography. In the system petroleum ether-ethyl acetate-acetic acid (4:2:0.1) on a Silufol plate. Inspection of the chromatogram has shown the presence of a large number of spots. Spots have been identified under the action of ultraviolet light. The Rf values, color, in visible light and under UV, of the detected spots are shown below (Table 1).

Table 1 - Thin layer chromatography of the poplar extract

No. spot	Rf	Spot color in visible light	Spot color in UV	Assumed compound class
1	0.58	Light yellow	Bright yellow	acids
2	0.47	Light yellow	Dark brown	acids
3	0.37	Light yellow	yellow	flavone
4	0.29	Light yellow	Dark brown	flavonol
5	0.24	No	No	flavonol
6	0.18	yellow-green	Dark brown	flavone
7	0.05	orange	red-brown	pigments
8	start	red-brown	red-brown	polyflavonoids

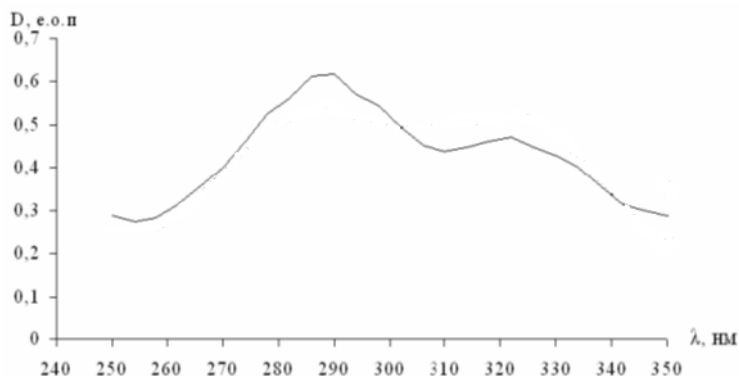
Identification of flavonoids during color reactions with 2% aluminum chloride, Synod's test, Briant's test, 1% basic lead acetate solution, 10% sodium hydroxide solution shows the following results. As a result of the qualitative reactions, characteristic reaction results have been obtained in all studied samples, confirming the presence of flavonoids (Table 2).

Table 2 - Color reactions for flavonoids

Qualitative reaction	Observation	Reaction results
Reaction with 2% aluminumchloride	Yellow staining	+
Sample of the Synod	Orange-red coloration	+
Briant'stest	The both layers (octanol and the original phase) were stained	The raw materials contain flavonoids both in the form of glycosides and in the form of aglycones
Reaction with a 1% solution of lead acetate basic	Pink staining	+
Reaction with 10% sodium hydroxide solution	Green staining	+

The determination of the presence of flavonoids in the initial alcohol extract, obtained from the balsam poplar buds has been carried out using UV spectroscopy (Figure 1).

Figure 1 shows that the UV spectrum of the alcohol extract of balsam poplar buds has a main absorption maximum at a wavelength of about 290 nm. Similar results have been obtained for a pinostrobin sample solution [10–11]. In addition, this region of the UV spectrum contains one of the absorption maxima of hydroxycinnamic acids, in particular ferulic acid (λ max 291 nm), which are present in poplar buds. It is known that a solution of caffeic acid (λ max 299 nm), also found in the extract from poplar buds, has a similar UV spectrum [12]. The comparison of the obtained results with the literature data has made it possible to conclude that the nature of the absorption curve of the poplar bud extract is determined mainly by the substances of a flavonoid nature.

**Figure 1** - UV spectrum of the alcohol extract of balsam poplar buds

One of the most important functions of phenolic substances is their participation in the process of respiration due to reversible oxidation and reduction; in addition, these compounds also perform protective functions in plants, associated with the exposure to the adverse environmental conditions [13–

14]. Phenolic compounds are involved in the process of plant growth, acting as stimulants, and are formed most intensively in young, vigorously growing tissues, which include plant buds [15–18].

The effectiveness of the growth stimulator on the seed productivity of northern flax has been carried out according to two options: option 1 - control, soaking the seeds in distilled water; option 2 - soaking the seeds in a 0.05% aqueous solution of poplar bud extract.

As can be seen from the data in Table 3, there is a significant difference in the growth-stimulating activity of the drug Option 2, that is, poplar bud extract. Compared to the control, in which the germination energy is 54-60%, the introduction of the poplar bud extract increases the germination energy up to 86-88%.

Table 3 - Parameters of the quality indicators of northern flax seeds

No.	Parameters	Number of germinated seeds, pcs	
		Variant 1	Variant 2
1.	Days		
	1	Missing	Missing
	2	24-29	48-52
	3	53-59	65-70
	4	61-63	81-85
	5	64-66	89-94
	6	69-73	94-100
	7	76-80	100
	8	80-85	100
2.	Germination energy, %	52-58	83-87
3.	Germination, %	80-85	100

The effect of treatment of seeds and crops of flax with the extract from the balsam poplar buds, collected in the awakening phase, on the productivity indicators is presented in Table 4.

Table 4 - The effect of seed treatment and flax crops with the extract from the balsam poplar buds, collected in the awakening phase, on the productivity indicators

	Parameters	Values
1	Additional seed dressing efficiency, %	15.2
2	Increasing the laboratory energy of seed germination, %	9-10
3	Increasing laboratory germination, %	2-3
4	Increase in the field germination, %	8.9-9.4
5	Decrease in weedseeds, %	32-44
6	Increasing the germination energy of the grown seeds, %	15-18
7	Increasing the germination of the grown seeds, %	3-4
8	Additional productivity, c/ha	2.8-3.3

The effect of the drug on the process of growing flax:

- pre-sowing treatment of seeds with the drug increases the energy of germination and seed germination, forms a powerful branched root system, increases the resistance of plants to diseases and adverse climatic conditions (drought, low temperature, soil salinity);

- pre-sowing treatment of seeds with the preparation is compatible with seed treatment with disinfectants, enhances their effectiveness, while the need for the latter is reduced by 30-50%;

- foliar feeding of crops with the preparation in the tillering phase increases the intensity of plant respiration by 2-4 times, the intensity of transpiration (water consumption) decreases by 1,8-2,4 times;

- foliar top dressing of crops with the drug is compatible with the treatment of crops with herbicides, without reducing the effectiveness of weed damage, while there is no onset of a disease state of crops after treatment with herbicides;

- an increase in sowing density by 10-11%, a decrease in infectious diseases by 39-47%, a decrease in weed infestation by 25-42%.

4. Conclusion

During the study, flavonoids have been isolated from the balsam poplar buds. The presence of flavonoids in the ethanol extract has been confirmed by qualitative reactions.

The composition of the extract of poplar buds has been studied by thin layer chromatography. It has been established that the composition of the extract from poplar buds mainly contains substances of a flavonoid nature.

The results of studying the growth-stimulating activity of the extracts of balsam poplar *Populusbalsamifera* have shown high seed productivity of flax of the Tomsk selection in the control group. Reproduction conditions has had a positive effect on the yield of flax.

Thus, balsamic poplar extract has a high stimulating activity and can be used as a natural plant growth stimulator.

Conflict of Interest: The authors declare that they have no competing interests.

POPULUSBALSAMIFERA БАЛЬЗАМДЫ ТЕРЕК БҮЙРЕГІ СЫҒЫНДЫЛАРЫНЫҢ ФЛАВОНОИДТАРЫНЫҢ ӨСУІН ҒЫТТАЛАНДЫРАТЫН БЕЛСЕНДІЛІК

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Түйіндемe. *Кіріспе.* Қазіргі уақытта өсімдіктерді қорғаудың балама шараларын жеделдету міндеті тұр, бұл экологиялық жағдайдың нашарлауына, агрохимикаттарды барынша аз пайдалана отырып, Агроландшафттардың ластануын азайтуға және ауылшаруашылығы өнімдерін алуға ұмтылу мен байланысты. Терек сығындысы құрамында қаныққан және қанықпаған майқышкылдарының, липидтердің, фенолды және полифенолды қосылыстардың, аминқышкылдарының,

эфирмайларының, тұрақты өсуді ынталандыратын әсерді қамтамасыз ететін дәрумендердің болуына байланысты өсімдіктердің өсуін ынталандырады. Терек бальзамына негізделген биологиялық препараттардың артықшылықтарына олардың төмен құны, өсімдіктердің өнімділігін етеріс әсеретпеуі, жоғары ерекшелігі, төмен уыттылығы жатады. Биологиялық препараттардың өсімдіктерді қорғаудың басқа құралдарынан басты айырмашылығы-олар өсімдіктердің табиғи қорғаныс қабілеттерін ынталандыруға қабілетті, осылайша зиянды организмдерге әсеретеді. Мұндай препараттарды қолдану ауылшаруашылығындағы экологиялық мәселелерді шешудің біржолы және өсімдіктерді фитопатогендерден және жалпы өсімдік шаруашылығынан қорғаудың тиімділігін арттырудың қуатты құралы болып табылады. *Жұмыс мақсаты* – бальзамдық *populusbalsamifera* терек бүршігі сығындыларының зығыр тұқымының өнімділігіне ынталандырушы белсенділігін бағалау. Міндеттері: бальзамдық теректен флавоноидтардың қосындысын бөліп алу; зығыр тұқымына қатысты бальзамдық терек бүршігі сығындысының өсуін ынталандыратын белсенділігін анықтау. *Әдістер*: ұсынылған бальзамдық терек сығындысын алу тәсілі, бальзамдық терек бүршіктерін пайдалануды, ауада кептіруді, ұнтақтауды, Соксле таппаратында 90% этанолды алуды, мақсатты өнімді алғанға дейін сүзуді және буландыруды қамтиды. *Нәтижелер және талқылау*. Зерттеу барысында бальзам терегінің бүршіктерінен флавоноидтар оқшауланды. Этанол сығындысында флавоноидтардың болуы сапалы реакциялар арқылы расталады. Терек бүйрексығындысының құрамы жұқа қабатты хроматография әдісімен зерттелді. *Тұжырым*. Терек бүршіктерінен алынған сығындының құрамында негізінен флавоноидты сипаттағы заттар бар екендігі анықталды. Бальзамдық *populusbalsamifera* терексығындыларының өсуінің ынталандыратын белсенділігін зерттеу нәтижелері бакылау тобында Томск селекциясының зығырының жоғары тұқым өнімділігін көрсетті; көбею жағдайлары зығыр өнімділігіне оң әсеретті.

Түйінді сөздер: флавоноидтар, *Populusbalsamifera*, өсімді ынталандыратын белсенділік, зығыртұқымы, сығынды

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РОСТОСТИМУЛИРУЮЩАЯ АКТИВНОСТЬ ФЛАВОНОИДОВ ЭКСТРАКТОВ ПОЧЕК ТОПОЛЯ БАЛЬЗАМИЧЕСКОГО *POPULUS BALSAMIFERA*

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Резюме. *Введение.* В настоящее время остро стоит задача ускоренной разработки альтернативных мер защиты растений, что связано с усугублением экологической ситуации, стремлением уменьшить загрязнение агроландшафтов и получать сельскохозяйственную продукцию с минимальным использованием агрохимикатов. Экстракт тополя является стимулятором роста растений благодаря наличию в своем составе насыщенных и ненасыщенных жирных кислот, липидов, фенольных и полифенольных соединений, аминокислот, эфирных масел, витаминов, которые обеспечивают стабильное ростостимулирующее действие. К достоинствам биологических препаратов на основе тополя бальзамического можно отнести их низкую стоимость, отсутствие отрицательного влияния на продуктивность растений, высокую специфичность, низкую токсичность. Основное отличие биологических препаратов от остальных средств защиты растений состоит в том, что они способны стимулировать естественные защитные способности самих растений, влияя тем самым на вредные организмы. Применение таких препаратов является одним из путей решения экологических проблем в сельском хозяйстве и мощным средством повышения эффективности как защиты растений от фитопатогенов, так и растениеводства в целом

Цель - оценить стимулирующую активность экстрактов почек тополя бальзамического *Populusbalsamifera* на семенную продуктивность льна. Задачи: выделить сумму флавоноидов из тополя бальзамического; установить ростостимулирующую активность экстракта почек тополя

бальзамического по отношению к семенам льна. *Методология* и научные подходы: Способ получения предлагаемого экстракта тополя бальзамического, включает использование почек тополя бальзамического, высушивание на воздухе, измельчение, экстракцию 90% этанолом в аппарате Сокслета, фильтрацию и упаривание до получения целевого продукта. *Результаты и обсуждение.* В процессе исследования были выделены флавоноиды из почек тополя бальзамического. Присутствие флавоноидов в этанольном экстракте подтверждено с помощью качественных реакций. Был исследован состав экстракта почек тополя методом тонкослойной хроматографии. *Выводы.* Установлено, что в составе экстракта из почек тополя в основном содержатся вещества флавоноидной природы. Результаты изучения ростостимулирующей активности экстрактов тополя бальзамического *Populusbalsamifera* показали высокую семенную продуктивность льна томской селекции в контрольной группе; условия воспроизводства положительно повлияли на урожайность льна.

Ключевые слова: флавоноиды, *Populusbalsamifera*, ростостимулирующая активность, семена льна, экстракт

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