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OBTAINING OF BALSAMIC POPLAR EXTRACT AS BIOSTIMULANT FOR AGRICULTURAL PLANTS

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ABSTRACT

Modern varieties of agricultural plants have reached the limits of natural genetic variability in a few key parameters, and a further significant increase in their productivity and stress resistance using traditional approaches is extremely difficult. The use of biostimulants of various nature is considered as a promising way of sustainable development, allowing to increase yields without harmful effects on the environment. Plants are a source of a wide variety of biologically active substances (BAS), such as vitamins, alkaloids, glycosides, saponins, tannins, polysaccharides (gums, mucus, pectins, inulin, fibre, starch), flavonoids, resins, essential and fatty oils, organic acids, phytoncides, pigments and others. An important argument in favour of obtaining biologically active substances from poplar is the environmental friendliness of such a solution, since a lot of unused waste (bark, branches, wood) is generated during the logging process.

The purpose of this study is to find the optimal extraction conditions and to investigate the influence of balsamic poplar extract on the change in physiological and biological parameters, as well as the productivity of soybean, cucumber, and sugar beet seeds.

The qualitative composition of extracts from buds, twigs, catkins, and poplar wood processing waste has been determined. Among these extracts, the one from poplar wood processing waste is the most promising for further study due to its high content of flavonoids, tannins, saponins, amino acids, and polysaccharides. The optimal technological parameters for extracting these compounds have been identified, including the degree of grinding of the raw materials, the ratio of raw materials to extractant, the duration of extraction, and the concentration of the extractant. It has been found that the best extraction of flavonoids occurs when the raw materials are ground to a size of up to 15 mm and mixed with a ratio of 1:15 of raw materials to extractant for 36 hours using 96 % ethanol.

The aftereffect of the application of the extract was traced in the ontogenesis of plants on the change in important physiological processes that influenced the productivity of products and their quality.

Keywords: Populus balsamifera, extraction, poplar, ethanol, soybean seeds, cucumber seeds, sugar beet seeds.

INTRODUCTION

The use of biostimulants is one of the ways to increase the yield and sustainability of agricultural plants, which has been actively developed in recent years [1]. Currently, the market is filled with quite a lot of different types of growth stimulants. However, data on their effectiveness in specific soil-climatic conditions is clearly insufficient [2]. Physiological activity of these drugs manifests itself in stimulating plant growth processes and reducing negative effects of stress factors. Their use allows increasing the efficiency and reducing the fertilizer use. Biostimulants can stimulate the activity of "useful" soil microorganisms and plant absorption of nutrients from the soil. The anti-stress properties of biostimulants under drought conditions have been shown such as salinity, low and high temperatures, negative effects xenobiotics [3]. In addition, some biostimulants may exhibit fungicidal properties, as well as activate protective reactions in plants, which causes a decrease in the prevalence and degree of development of diseases. Some biostimulants may have protective properties against nematodes and viruses. Biochemical aspects of the use of biostimulants are associated with changes in hormonal status and metabolic processes in plants [4]. The main regulators of the cell cycle in plants are phytohormones that control the passage of different phases of cell division. In addition, some biostimulants contain essential growth hormones in plants that are capable of accelerating cell cycle processes. Importantly the need to assess the effect of biostimulants on the cell cycle is a general biological problem both in connection with morphogenesis and adaptation to stressors of various natures [5].

One of the sources of biostimulants are trees, which is justified both from an economic and environmental point of view.

Flavonoids are the most extensive group of phenolic compounds and an important component of the plant organism [6]. They take an active part in redox processes, the development of immunity, the protection of plants from the adverse effects of ultraviolet rays and low temperatures. Flavonoids are active metabolites of the plant cell. The important biological role of these compounds is evidenced by the nature of their distribution in the plant. Most flavonoids are found in actively functioning organs: leaves, flowers, fruits (color, aroma), seedlings, as well as in integumentary tissues that perform protective functions. Different organs and tissues differ not only in quantity, but also in the qualitative composition of flavonoids [7].

One of their most important functions is participation in redox processes. Oxidized by atmospheric oxygen, with the participation of polyphenol oxidase, they are converted into the corresponding quinones, which are reduced by the hydrogen atoms of the respiratory substrate and again become available for the action of polyphenol oxidase. Thus, the flavonoid-polyphenol oxidase system serves as a carrier of hydrogen atoms at the final stages of the respiration process [8]. These reactions are important for plant physiology. Thus, the oxidation of tryptophan with quinone leads to the formation of a plant growth stimulant, β-indoleacetic acid. Flavonoids are involved in many important processes associated with plant germination, growth, pollination, and reproduction.

Tannins are one form of reserve nutrients. This is indicated by their localization in the underground organs and the cortex; tannins perform a protective function, e.g. when plants are damaged, they form complexes with proteins that create a protective film that prevents the penetration of phytopathogenic organisms. They have bactericidal and fungicidal properties; participate in redox processes, are oxygen carriers in plants [9].

The biological role of coumarins is currently an important topic for study. Depending on the concentration in fruits, coumarins can act as growth inhibitors or activators and promote seed germination. They have protective properties in some plant diseases, as they exhibit antimicrobial properties.

Saponins in low concentrations accelerate seed germination, growth, and development of plants, and in high concentrations, on the contrary, they slow down. Thus, saponins play the role of plant growth hormones; saponins affect the permeability of plant cells, which is associated with their surface activity [10].

Amino acids are of key importance for the development of the flora representatives. In plant organisms, they appear during photosynthesis, and then are involved in a huge list of biochemical reactions, supporting optimal growth and development [11].

Natural resources are exhaustible, so their use must be careful. And for this, it is optimal to use wood processing waste as a raw material without damaging nature.

The cultivation of soybeans, sugar beet and cucumber are of great importance for agriculture.

Soy is a valuable food, industrial and fodder crop. Soybean seeds contain up to 49 % protein, 15 - 26 % fat, 23 - 25 % carbohydrates and the most important vitamins necessary for humans and animals: A, B, C, D, E [12]. The main protein of soy protein glycine in amino acid composition is close to meat amino acids and can almost completely replace meat protein. Soybeans are grown in more than 60 countries, the sown area is 360 million hectares, and the gross harvest is 377.2 million tenge [13]. The main regions of soybean cultivation in Kazakhstan are the south and south-west of the Republic. In 2022, with a total sown area in the Republic of Kazakhstan of 113.3 thousand hectares, in the Almaty region, 97 thousand hectares were occupied with soybeans, i.e. more than 85 % [14]. The Republic of Kazakhstan, as a country with intensively developing animal husbandry, needs to strengthen its own fodder base. In the livestock industry, there is constantly a significant shortage of products due to the imbalance of feed not only in protein, but also in essential amino acids. An expedient and cost-effective way to solve the problem of vegetable protein deficiency in feed is to increase the use of high-protein grains of legumes. Soybeans, being the most common protein-oil crop in world agriculture, is capable, together with such leguminous plants as peas, lupins, and vetch, of solving the problem of lack of fodder protein [15].

Cucumber is one of the oldest cultures of world agriculture, which appeared more than 6 thousand years ago [16]. Large traditional cucumber growing areas are the central regions of the Russian Federation, the Volga region, the North Caucasus, Ukraine, Belarus, Kazakhstan, and Moldova. Recently, breeders have created highly productive varieties and hybrids of cucumber, resistant to diseases and pests, responsive to fertilizers, irrigation, suitable for mechanized cultivation and harvesting. Cucumber fruits do not have a high energy value, but due to their high nutritional qualities, they are widely used [17].

Sugar beet is one of the most important industrial crops. Currently, more than 30 % of world sugar production is obtained from sugar beets [18]. Large sugar beet producing countries are Russia, Ukraine, France, USA, Poland, Germany, Italy, Romania, Spain, Czech Republic, Great Britain, Belgium, Hungary, Turkey. 70 - 80 % of all sown areas and gross harvest of sugar beets are in European countries [19].

The purpose of this study is to find the optimal extraction conditions and to investigate the influence of balsamic poplar extract on the change in physiological and biological parameters, as well as the productivity of soybean, cucumber, and sugar beet seeds.

EXPERIMENTAL

Samples for analysis

Balsam poplar buds, twigs, leaves, earrings were collected in March-May 2023 in the vicinity of the village of Zarechny, North Kazakhstan region. Freshly harvested poplar buds were crushed to a size of 2 - 5 mm, filled with a 96 % technical ethanol GOST 57251-2016 to obtain an extract, filtered through a paper filter. Soybean Kazakhstanskaya 2309, sugar beet variety Yaltushkovskaya one-seeded 30 - a variety of high-yielding sugar direction, highly productive, characterized by significant plasticity, cucumbers of the Stella variety were chosen as the object of study.

Sample preparation

The balsamic poplar extract was obtained of fresh balsam poplar catkins, harvest time May. The poplar extract was obtained from fresh balsam poplar buds collected in March. The extract from poplar twigs isolated of fresh balsamic poplar twigs collected in March. The extract from poplar wood processing waste (buds, twigs, catkins, leaves) was produced from balsamic poplar wood processing waste collected in May. The initial raw materials were grinded and an extraction with 96 % ethanol at room temperature was conducted, followed by filtration of the solutions.

The results are presented with convenient interval at level of confidence (95 %) on base of four replicates. Student's t is used to find confidence intervals and to compare mean values [20].

$$\Delta y = t_{\alpha f} \frac{s}{\sqrt{n}} \quad (1)$$

Methods of BAS analysis

Chemical analysis in the studied extracts was carried out according to known methods and the method of drop analysis was investigated for the presence of the main groups of biologically active substances (BAS) [21]. For the study, extracts were taken from buds, catkins, poplar twigs, wood processing waste.

Quantitative determination

For the quantitative determination of biologically active substances by the spectrophotometric method, the wavelength (max) with the maximum value of the absorption of the test solution was preliminarily determined. The data were taken from the UV mini-1240 spectrophotometer in a cuvette with a liquid layer thickness of 1 cm.

Procedure for determining extractive substances

100 grams of raw material were poured into 200 mL of an organic solvent and infused for 3 days. Ethyl alcohol was used as a solvent. Then 5 mL of the concentrated extract was evaporated to dryness in a porcelain dish in a water bath. Further drying to constant weight was carried out in an oven at a temperature of 100°C - 105°C. The percentage of extractives was calculated from the weight of the dry raw materials.

The content of extractives in dry material/preparation in percent (X) was calculated by the formula:

$$X = \frac{m*100*100*V}{a*25*(100-w)} \quad (2)$$

where *m* is the mass of dry residue, g; *a* - a sample of medicinal plant material/preparation, g; *V* is the volume of the extractant used in a single treatment of the medicinal herbal raw material/preparation, mL, *w* is the moisture content of the medicinal plant material/preparation, %, weight loss on drying - not more than 10 %.

Quantitative determination of flavonoids

About 0.450 g (accurately weighed) of the substance (concentrated extract) is placed in a volumetric flask with a capacity of 50 mL, 25 mL of ethyl alcohol 96 % is added, stirred until dissolving and the volume of the solution is brought to the mark with ethyl alcohol 96 %. Next, 5.0 ml of the resulting solution is placed in a volumetric flask with a capacity of 10 mL, 1 mL of a 25 % solution of aluminium chloride is added and the volume of the solution is brought to the mark with ethyl alcohol 96 %.

After 40 min the absorbance of the resulting solution is measured on a spectrophotometer at a wavelength of 430 nm in a cuvette with a liquid layer thickness of 10 mm, using as a comparison the mixture prepared in a volumetric flask with a capacity of 10 mL: 5 mL of the test solution is adjusted to the mark with ethyl alcohol 96 %.

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

$$X = \frac{A*100*100*100*25}{764,6*m*2*(100-w)} \quad (3)$$

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

Test for physiological activity of extracts

Soybean seeds (100 seeds each) were germinated in Petri dishes on filter paper in 0.03 % solutions of the studied extracts in the dark at a constant temperature of 20°C for 7 days. Distilled water was used as a control. According to GOST 12038-84, the germinated seeds were counted in the experiment on the 3rd and 7th days, using a 4-fold repetition [22].

Before sowing, sugar beet seeds were soaked in 0.03 % aqueous emulsion of balsamic poplar extract for 24 hours. Sowing was carried out with a row spacing of 45 cm. During the growing season, phenology, biometrics, physiological analyses, and crop records were carried out. Observations and analyses were carried out in accordance with classical methods.

The physiological activity of the extract on cucumber seeds was determined by soaking in a 0.03 % aqueous emulsion of balsamic poplar extract for 24 hours, foliar feeding of seedlings at a concentration of 0.03 % and one-two foliar feeding of vegetative plants in the phase of flowering and the beginning of fruit formation.

Influence of biostimulants on the intensity of respiration

The breathing intensity was determined according to the amount of carbon dioxide released in a closed vessel (according to Boysen -Jensen) [23].

Effect of biostimulants on chlorophyll content

A sample of leaves (0.1 g) was placed in a porcelain mortar, dry calcium carbonate was added at the tip of a spatula, rubbed with 2 - 3 mL of 80 % acetone, then 10 mL of acetone solution was added and rubbed continued for 10 min. The resulting extract was filtered into a 25 mL volumetric flask. The extraction was carried out step by step using a pure solvent, achieving complete discoloration of the leaf tissues. The exhaust volume was adjusted to the mark. The spectrophotometric analysis of the extract was carried out at 670 nm in 1 cm cuvette. The reference solution was pure 80 % acetone.

Six standard solutions of chlorophyll in concentration interval from $9.4x10^{-6}$ to $9.4x10^{-5}$ mol L^{-1} were prepared in a 25 mL volumetric flask and diluted to the mark with a 7 % ammonia solution to prepare a calibration curve. The spectrophotometric measurements were carried out at 670 nm in 1 cm cuvette. The reference solution was distilled water.

Effect of biostimulants on water metabolism

The intensity of transpiration was measured by the method of rapid weighing of Ivanov. Briefly, change in the weight of the system (part of the leaf) during 3 min exposure [25]. The measurements were carried out over a period of 2 hours.

RESULTS AND DISCUSSION

To determine the qualitative composition of the studied extracts, known qualitative reactions for flavonoids, tannins, coumarins, saponins, amino acids, and polysaccharides were used (Table 1).

As can be seen from the results in the Table 1, flavonoids are contained in each of the tested extracts. Tannins are present in bud and twig extracts but absent in catkin extract. The content of coumarins was found in all the tested extracts. Saponins are found only in bud and twig extracts. Amino acids can be traced in the extracts of catkins and twigs, in the extract of the kidneys are absent. The content of polysaccharides was found only in the extract of twigs, in the first two they were absent. In the extract obtained from poplar wood processing waste, all classes of the studied substances were found.

Thus, it can be concluded that the extract from poplar wood processing waste is the most promising for study, since it contains flavonoids, tannins, saponins, amino acids, and polysaccharides.

The leading group of biologically active compounds (BAS) of poplar buds are flavonoids (about 30 %), among which the flavanones pinocembrin and pinostrobin dominate. One of the most important functions of phenolic substances is their participation in the process of respiration due to the reversible oxidation and reduction; in addition, these compounds also perform protective functions in plants associated with exposure to adverse environmental conditions [26]. Flavonoids 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 [27].

Quantitative determination of extractives and flavonoids

The efficiency of technological parameters was determined by the yield of flavonoids and extractives. During extraction, not only biologically active, but also ballast substances pass into the extract. Therefore, the end of the extraction process must be judged not by the number of extractives, but by the number of the active substances.

Table 1. Qualitative group composition.

BAS group	Qualitative reaction	Extract of			
		Buds	Earring	Twig	Wood waste
Flavonoids	Aluminium trichloride	Formation of			
		yellow precipitate	yellow-green precipitate	yellow precipitate	yellow precipitate
Tannins	Lead acetate solution	Precipitation of curdled sediment			
		YES	NO	YES	YES
Coumarins	Lactone test	Formation of a white precipitate			
		YES	YES	YES	YES
Saponins	Stable foam in HCI solution	YES	NO	YES	YES
Amino acids	Ninhydrin reaction	Purple staining			
		NO	YES	YES	YES
Polysaccharides	Alcohol precipitation	Formation of a white precipitate			
		NO	NO	YES	YES

The indicator “extractive substances” characterizes the content of the total amount of biologically active and ballast substances extracted by the extractant in the medicinal plant material/preparation.

The degree of grinding, which provides the highest yield of extractives and the lowest cost of extractant and time, was determined directly when obtaining an extract from plant materials. The crushed raw material with different particle sizes of 3, 5, 10, 15 mm was poured with extractant and infused for 3 days.

As can be seen from the data obtained, the maximum yield of extractives was obtained by grinding raw materials to 3 mm, however, grinding does not have a significant effect on the extraction of flavonoids. Thus, there is no need to grind the raw material more than 15 mm.

Table 2. Influence of the degree of grinding on the yield of extractives and the number of flavonoids.

Degree of grinding, mm	Extractives, %	Flavonoids, %
15	18.6 ± 0.5	6.3 ± 0.5
10	18.9 ± 0.4	6.3 ± 0.5
5	18.9 ± 0.4	6.0 ± 0.4
3	19.0 ± 0.4	6.3 ± 0.5

Raw material-extractant ratio

The concentration difference is the main driving force of the diffusion process. The diffusion process during extraction proceeds until a dynamic equilibrium of concentrations in the solid-liquid system is established. Therefore, during the extraction process, it is necessary to maintain the maximum difference in concentrations, practice by mixing, circulating the extractant or replacing the extraction with pure extractant (can be done periodically and continuously). Table 3 presents the results of the dependence of the yield of extractives and flavonoids on the ratio of raw materials-extractant.

Table 3. The influence of the ratio of raw materials-extractant on the yield of extractives and the number of flavonoids.

Raw material: extractant ratio	Extractives, %	Flavonoids, %
1:5	17.1 ± 0.7	0.3 ± 0.1
1:7	17.0 ± 0.9	0.4 ± 0.1
1:10	17.1 ± 0.9	0.5 ± 0.1
1:12	18.0 ± 0.8	0.6 ± 0.1
1:15	19.4 ± 0.7	1.1 ± 0.1

The data obtained indicate that at a ratio of raw material-extractant of 1:15, the yield of extractives and flavonoids is maximum.

Extraction duration

In most cases, extraction proceeds most actively in the first hours, and then, despite the use of a new portion of the extractant, its rate decreases, and extraction occurs after a relatively long time. Therefore, it is advisable to stop the extraction process when the expected (calculated) additional extraction of active ingredient residues does not pay off with excess costs for extractants.

Active substances (for example, alkaloids, glycosides, etc.) have a lower molecular mass (300 - 500), due to which they diffuse faster than high-molecular substances, therefore, in some cases, an increase in the duration of extraction is impractical (the quality composition of the extraction deteriorates due to the high content of ballast substances). Therefore, it is necessary to strive to accelerate the completeness of extraction, using all the factors leading to the intensification of the extraction process. Acceleration of the extraction process is also advisable from an economic point of view (mass transfer increases).

The dependence of the duration of extraction on the establishment of a dynamic equilibrium of concentrations in the process of extraction was determined by the yield of extractives and flavonoids (Table 4).

The data in Table 4 indicate that with an increase in the duration of extraction, the yield of extractives and flavonoids increases, however, after 36 hours of extraction, the extraction of flavonoids does not change, the yield of extractives increases slightly. Thus, the optimal extraction time is 36 hours.

To establish the concentration of ethyl alcohol necessary for the maximum extraction of extractives and flavonoids, experiments were carried out with ethanol solutions with different contents (Table 5).

Based on the data in Table 5, we can conclude that the highest extraction of extractives and flavonoids is facilitated using an alcohol concentration of 96 %.

Table 4. The effect of the duration of extraction on the yield of extractives and the number of flavonoids.

Extraction time, h	Extractives, %	Flavonoids, %
6	23.6 ± 0.5	1.9 ± 0.3
12	29.8 ± 0.6	2.3 ± 0.3
24	28.8 ± 0.6	2.6 ± 0.4
36	29.9 ± 0.6	2.6 ± 0.4
48	29.9 ± 0.5	2.6 ± 0.3

Table 5. The effect of the extractant on the yield of extractives and the number of flavonoids.

Extractant	Extractives, %	Flavonoids, %
Water	16.0 ± 0.3	2.5 ± 0.4
10 % ethanol	19.6 ± 0.4	2.5 ± 0.4
30 % ethanol	22.5 ± 0.4	2.7 ± 0.4
50 % ethanol	23.7 ± 0.3	2.9 ± 0.3
70 % ethanol	23.7 ± 0.4	2.9 ± 0.3
96 % ethanol	24.0 ± 0.4	3.0 ± 0.4

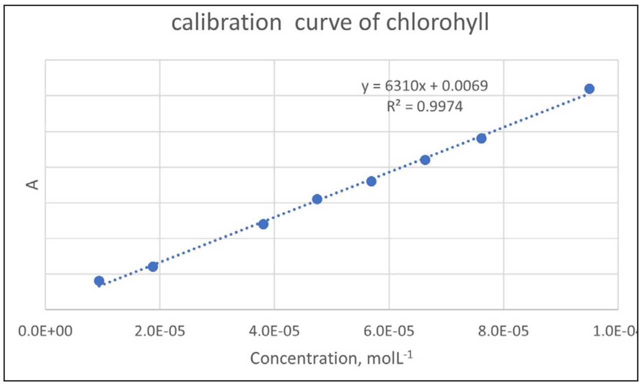

Fig. 1. Calibration curve of chlorophyll.

Influence of growth stimulants on changes in physiological and biochemical parameters and soybean productivity

The calibration curve of chlorophyll is presented on Fig. 1. The sensitivity of methods is $6.31x10^3$ L mol^{-1}. The total chlorophyll content was determined photometrically according to methods described in article [24].

The effectiveness of the growth stimulator on soybean seed productivity was carried out according to two options: option 1 - control, soaking the seeds in distilled water; option 2 - soaking the seeds in a 0.03 % aqueous solution of the extract of poplar wood processing waste (Table 6).

Sowing qualities (germination energy and germination) affect the growth and yield of plants. The germination energy of seeds soaked in 0.03 % poplar emulsion increased to 95 %. Germination in all variants of experience is above 85 %. The highest germination rate was noted when using 0.3 % poplar emulsion - 99 %.

One of the most important indicators of the biological quality of vegetable crops is their dry matter content. It should be noted that the content of dry matter in plants grown from seeds treated with 0.03 % poplar emulsion is 15 %, while in the control it is 11 % (flowering phase).

Measurement of the intensity of transpiration in plant ontogeny showed that plants grown from seeds treated with poplar extract used water more economically.

High respiratory intensity was noted in the experimental samples and amounted to 109 % in relation to the control.

The effectiveness of the technological method is ultimately determined by the main indicators - yield and product quality. The maximum yield of 42.17 centners/ha was obtained when seeds were treated with a 0.03 % solution of poplar oil, the yield increase was 119.8 % compared to the control of 35.3 centners/ha.

Influence of plant extracts on the growth and development of sugar beet

The influence of the use of plant extract on the growth and development of sugar beet was tested by soaking the seeds in a 0.03 % aqueous emulsion of the extract from poplar wood processing waste. Efficiency was determined by the main indicators - yield and product quality (Table 7).

In the experiment, the effect of seed treatment on the

Table 6. Changes in physiological and biochemical parameters and soybean productivity.

Experience Options	Soaking seeds in distilled water	Soaking seeds in a 0.03 % aqueous solution of poplar extract
Germination energy, %	80	95
Germination, %	88	99
Dry matter content, %	11	15
Chlorophyll content per dry leaf weight, μgg^{-1}	245.3	288.5
Transpiration rate, mgcm^{-2}h	1205	628
Breathing intensity, %	100	109
Yield, Productivity, tonnes per hectare (tha^{-1})	3.53	4.3
Yield increase, %	100	119.8

Table 7. Yield and product quality depending on the use of the extract.

Experience Options	Productivity, tonnes per hectare (tha^{-1})	Gain to control, %	Yield quality indicators		
			Average root weight, kg	Number of solids, %	Number of sugars, %
Sowing with dry seeds - absolute control	83.2	100	0.8	21.8	22.8
Soaking seeds in water - control 2	86.6	104	0.8	21.1	24.3
Soaking seeds in 0.03 % water emulsion of the extract	110.7	133	0.9	25.2	30.0

Table 8. Influence of the extract on the growth and development of cucumber variety "Stella".

Experience Options	Indicators					
	Stem length, cm	Number of leaves, pcs	Leaf area, dm^2	Internode length, cm	Number of flowers, pcs	Number of fruits, pcs
Sowing with dry seeds - absolute control	189.3	21.4	4.6	12.4	8.4	12.1
Soaking seeds in 0.03 % water emulsion of the extract	203.4	22.5	4.7	10.3	8.9	12.3
Seed soaking in 0.03 % extract water emulsion + foliar application	207.6	23.4	4.5	10.2	9.3	12.3
Double foliar top dressing	197.0	18.4	4.9	10.1	10.8	9.7

rate of growth and development of plants was traced. The highest yield of 1107.0 centners/ha was obtained using poplar extract, the yield in the control was 832 centners.

Pre-sowing treatment had an impact not only on the increase in yield, but also on the content of carbohydrates. In the control, the carbohydrate content was 22.8 %, with the use of an extract of 30 %.

The effectiveness of the use of plant extracts on cucumber culture

Experiments were carried out with cucumbers of the Stella variety. The physiological efficiency of the extract was determined by soaking the seeds in a solution of 0.03 % concentration for 24 hours (Table 8).

Seed treatment has an aftereffect on the growth rate

Table 9. The effect of the use of the extract on the yield of Stella cucumber variety.

Options	Yield for the first month of fruiting, kgm^{-2}	Yield for the entire period of fruiting, kgm^{-2}
Sowing with dry seeds - absolute control	1.9	3.13
Soaking seeds in 0.03 % water emulsion of the extract	2.4	5.24
Soaking seeds in a 0.03 % aqueous emulsion of the extract + foliar feeding of seedlings	2.3	5.27
Twice foliar application with 0.03 % extract water emulsion	2.8	5.43

of seedlings, which is confirmed by such indicators as the length of the stem, the number of leaves, flowers, fruits. As can be seen from the data in Table 8, using the extract, the length of the internode is noticeably reduced, which means that the number of ovaries formed on the plant increases, which subsequently leads to an increase in the yield. The aftereffect of seed treatment can be traced in the ontogenesis of the plant. Experimental plants are characterized by accelerated development rates, the length of the main stem, the length of the internode (Table 9).

The yield of cucumber variety Stella in the first crop rotation with the use of the extract was higher in the first month of fruiting.

CONCLUSIONS

The qualitative composition of extracts of buds, twigs, catkins, and popular wood processing waste has been established. The most promising for study is an extract from poplar wood processing waste, as it contains flavonoids, tannins, saponins, amino acids, polysaccharides. The optimal technological parameters for obtaining extracts are determined, such as: the degree of grinding of raw materials, the ratio of raw materials-extractant, the duration of extraction and the concentration of the extractant. It has been established that the greatest extraction of flavonoids is facilitated by the degree of grinding of raw materials up to 15 mm in the ratio of raw materials: extractant 1:15 for 36 hours with 96 % ethanol. The optimal concentration of balsam poplar extract (0.03 %) had a significant impact on the sowing quality of seeds (energy and germination). The use of an extract of poplar wood processing waste had a significant impact on morphogenesis, physiological and biochemical parameters, and the productivity of soybean, cucumber, and sugar beet seeds. The action of the extract increases the sowing qualities of seeds. The aftereffect of the application of the extract was traced in the ontogeny of plants on the change in important physiological processes that influenced the productivity of the product and its quality.

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