Prospects for alternative woody plants in Siberia

Shimova Iuliia Sergeevna
Candidate of Chemical Sciences, Associate Professor
Reshetnev Siberian State University of Science and Technology
Kositcyna Anna Sergeevna
Candidate of Chemical Sciences, Associate Professor
Reshetnev Siberian State University of Science and Technology
Lis Elena Valerievna
Candidate of Chemical Sciences, Dean
Reshetnev Siberian State University of Science and Technology

Abstract. The article presents the main results of the study of the chemical composition of greenery and paulownia felt wood and discusses the prospects for complex use in various industries.

Keywords. Paulownia, woody greens, wood, biologically active substances, polyphenols, cellulose, nitrogen-containing substances, extractives.

At present, in connection with the increase in the use of forest resources, the deterioration of the ecological situation, climate change, the problem of reforestation is acute all over the world. In Siberia, this problem is relevant due to the rather low growth rate of coniferous woody plants, annual forest fires, unfavorable anthropogenic factors and harsh climatic conditions. This problem can be solved by using alternative forest resources that have a high growth rate, are resistant to adverse factors and have practical value. One of these trees is Paulownia, a fast-growing tree native to China, which in several years grows up to 30 m in height and up to a meter in diameter. This tree is especially widespread in the United States and European countries, where it is widely used for landscaping urban gardens and squares, preventing erosion and soil pollution. It is noted that paulownia is quite resistant to unfavorable anthropogenic factors, is capable of absorbing heavy metals from the soil, has a developed root system, as well as rather large leaf plates. Along with a high growth rate and a unique ability to repeatedly recover from the root even after felling, it can be considered as a possible element of the landscape architecture of urbanized areas. However, according to numerous literature data, paulownia grows in a mild climate, in the temperature range from plus 35°C to minus 32°C [1 - 3].

We have not found data that allow us to assess the resistance to a wider temperature range characteristic of our region (according to Roshydromet, the highest temperature noted in

Krasnoyarsk is plus 36.4°C, and the lowest is minus 52.8°C.). In addition, despite the great interest shown in this plant, especially in recent years, the chemical composition has been studied fragmentarily, in connection with which it is relevant to study the chemical properties of paulownia felt, characterized by the highest low-temperature resistance, in order to consider the prospects for its further use both in reforestation and in the national economy.

Paulownia leaves, according to chemical studies, are rich in nitrogen and balanced in protein, amino acid and mineral composition. According to various sources, the chemical composition of Paulownia leaves is represented by 18 - 20% crude protein, while researchers note the presence of amino acids such as threonine; cysteine; valine; methionine; isoleucine; leucine; tyrosine; phenylalanine; histidine; lysine. Researchers note that the chemical composition of paulownia leaves corresponds to the chemical composition of alfalfa, which, as you know, due to its nutritional value, is the leader in the world production of feed additives [2 - 6].

Paulownia wood has long been widely used in various sectors of the national economy. The unique combination of such properties as high strength, moisture resistance, fire resistance, lightness allows it to be used in construction, furniture and musical instruments production, and its high carbohydrate content makes it a promising raw material for bioethanol production [2-6].

For the purpose of research, in June 2019, seeds of paulownia felt were planted in indoor ground, after six months it became possible to study the chemical composition of the leaves of grown samples, and a year later - the opportunity to study the chemical composition of paulownia wood. The study of the chemical composition was carried out according to the methods adopted in the chemistry of plant raw materials. The biomass was preliminarily dried and ground to a homogeneous state, samples for analysis were prepared by quartering, all results were statistically processed, the confidence interval is 95%. [7]. To assess the resistance of the grown samples to unfavorable climatic conditions, in June 2020 the plants were planted in open ground.

In the leaves and wood of paulownia, the content of moisture, protein, amino acids, cellulose, the content of extractives, pigments and polyphenolic compounds was determined. Sequential extraction was carried out with hexane, ethyl alcohol, aqueous alcohol solution, and water.

The content of extractives in the leaves of Paulownia was about 60%, of which in the hexane extract - about 11%, in the alcoholic and aqueous-alcoholic extracts - about 19%, in the aqueous extract - about 13%. The total content of extractives extracted from wood was about 18%, of which hexane, alcohol, aqueous-alcoholic extractant and water were about 4%, 8%, 2%, and 4%, respectively.

Further study of the chemical composition of the extractives of the studied samples showed that the content of polyphenolic compounds is high enough for plant materials and is about 10% in paulownia leaves, and about 6% in wood. This makes it possible to consider paulownia leaves and wood as a valuable source of biologically active substances and opens up prospects for the use of paulownia biomass in such industries as cosmetology, pharmaceuticals, and medicine.

The protein content in leaves was about 18%, in wood - about 3%; free amino acids in wood - about 0.5%, in leaves - about 2%. The high content of nitrogen-containing compounds and the good digestibility of woody greenery make it possible to recommend paulownia for use as a feed additive in animal husbandry.

The cellulose content in paulownia wood was about 47% of the absolutely dry weight of the sample, which corresponds to the average cellulose content in softwood and indicates the possibility of replacing traditional raw materials with alternative ones. The cellulose content in the leaves is about 36%. Such a high content of paulownia leaves makes it possible to consider biomass as a rapidly renewable source of industrial processing in order to obtain cellulosic materials.

Based on the results of the study of the chemical composition of wood and woody greenery, it can be concluded that this plant can be recommended for use as a raw material in medicine, perfumery, pharmaceutical industry, for the production of cellulose materials and products of its processing, as well as a feed additive for farm animals.

The high growth rate of paulownia, which makes it possible to obtain biomass suitable for industrial processing in one growing season, its ability to resume growth from the root at least 8-10 times after cutting, as well as its resistance to unfavorable factors, make it possible to consider paulownia as a promising raw material for obtaining cellulose materials based on it. In addition, despite the rather low winter temperatures (up to minus 40°C) and the lack of special care, the survival rate of plants a year after planting in open ground was more than 60%.

Thus, due to its high growth rate, resistance to unfavorable environmental factors and its chemical composition, paulownia can be considered as one of the alternative woody plants that can significantly reduce the environmental load, replacing the use of traditional coniferous woody plants of Siberia in various sectors of the national economy.

References

1. Ganchev G. Digestibility and energy content of Paulownia (Paulownia elongata S.Y.Hu) leaves / G. Ganchev, A. Ilchev, A. Koleva // Agricultural science and technology. – 2019. – Vol. 11, № 4. – P. 307-310.

2. Paulownia leaves as a new source of nutrition: chemical composition and influence on growth, digestibility, biochemistry of blood and intestines of growing rabbits / Adham A. Al-Saghir, Mohamed A. Abd El-Haq, Mahmoud Alagavani, etc. // Animals – Open access journal. 2019. № 9. P. 1-13.

3. The Paulownia tree an alternative for sustainable forestry / Sedeer ElShowk, Nabil El-Showk // Ain El Aouda: Crop Development. – 2003.

4. Alcoholic extracts from Paulownia tomentosa leaves for silver nanoparticles synthesis / Yosari S. Pontaza-Licona, A. L. Ramos-Jacques, J. A. Cervantes-Chavez, J. LuisLópez-Miranda and etc // Results in Physics. – 2019. – Vol. 12, № 4. – P. 1670-1679.

5. Paulownia – a source of biologically active substances. Amino acid composition of leaves / A. Koleva, K. Dobreva, M. Stoyanova, P. Denev and etc // Journal of Mountain Agriculture on the Balkans. – 2011. – Vol. 14, № 5. – P. 54- 62.

6. Digestibility and energy content of Paulownia (Paulownia elongata S.Y.Hu) leaves / G. Ganchev, A. Ilchev, A. Koleva // Agricultural science and technology. – 2019. – Vol. 11, № 4. – P. 307-310

7. V. M. Ushanova, O. I. Lebedeva, A. N. Devyatlovskaya. Fundamentals of Scientific Research. Investigation of the chemical composition of plant materials. Krasnoyarsk: SibSTU, 2004. 360 P.