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STUDY OF THE CHARACTERISTICS OF PAVLOVNIA TREE AND THE QUALITY INDICATORS OF THE OBTAINED CELLULOSE

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Annotation. In this article, some mechanical and physico-chemical indicators of paulownia wood are determined, cellulose is obtained by processing crushed fiber and its physico-chemical quality indicators are determined. Information is presented on the production of various paper products obtained from paulownia pulp and various products of high-quality cellulose ethers and esters.

Keywords: Properties of wood and paulownia, microscopic structure, wood fiber cells, cellulose, quality indicators.

Аннотация. В данной статье определены некоторые механические и физико-химические показатели древесины павловнии, получена целлюлоза путем переработки измельченного волокна и определены ее физико-химические показатели качества. Представлены сведения о производстве разных бумажных продукций полученной из павловной целлюлозы и разных изделий простых и сложных эфиров высококачественной целлюлозы.

Ключевые слова: Свойства древесины и павловнии, микроскопическое строение, клетки древесного волокна, целлюлоза, показатели качества.

Annotatsiya. Ushbu maqolada pavlovniya daraxtining mexanik va fizik-kimyoviy xususiyatlari aniqlanadi, maydalangan payraxalarni qayta ishlab va undan tsellyuloza olinadi hamda uning fizik-kimyoviy sifat ko‘rsatkichlari o‘rganildi. Pavlovniya sellyulozasidan olingan turli xil qog‘oz mahsulotlari va yuqori sifatli tsellyuloza oddiy va murakkab efirlarining turli xil mahsulotlarini ishlab chiqarish bo‘yicha ilmiy ma'lumotlar keltirilgan.

Kalit so‘zlar: Pavlovniya yog‘ochining xususiyatlari, mikroskopik tuzilishi, yog‘och tolasining hujayralari, tsellyuloza, sifat ko‘rsatkichlari.

INTRODUCTION.

Currently, research is being conducted in our Republic aimed at studying the cellulose components and their properties obtained from paulownia trees, due to the re-production of alternative energy sources and wood-based products. Research

is investigating the various methods used to extract cellulose from paulownia trees, including the study of the properties of the resulting cellulose [1-3].

The results of the conducted scientific research show that the quality of cellulose obtained from paulownia trees is higher than that obtained from other sources, in addition, paulownia plants are known to be used in pharmacology, cosmetology, animal husbandry, and are used for the production of wood cellulose. In another effort, our government is implementing various measures to support the cultivation of paulownia trees, including allocating land for plantations and leasing land to farmers and businesses for timber production. In addition, cultivation of paulownia trees is a profitable resource and efforts are underway to optimize cultivation through new innovative agro-technologies for their propagation [4-7].

Paulownia is a fast-growing tree with large leaves, about 70 cm in diameter, and flowers up to 6 cm in diameter, with a beautiful crown. The diameter of the tree is up to 1 meter. The average lifespan is up to 100 years. Depending on the growing environment, trees can reach a maximum of 25 meters and different heights [8].

Root system: superficial, long-rooted, without a distinct central root.

Undemanding to soil, it will grow in any dry soil with up to 2% lime, but it thrives best in deep, moderately moist, drained, fertile moist soil. Does not like drought and swamp.

Light tolerance: prefers sunny, open, well-lit places.

Frost resistance: very cold resistant, can withstand temperatures down to -28°C, and the buds freeze. It is sensitive to cold when it is young. It should be planted in places protected from winter winds.

Growth rate: grows very quickly, but slows down significantly in infertile soils. At 10 - 11 years old, depending on the species, it can reach 20 - 25 m.

Propagation: propagated by seeds and rhizomes.

Fruit: contains many seeds. It ripens in September-October. The seeds remain on the tree during the winter season and bear fruit at 5-6 years of age. One tree can produce up to 20 million seeds per year.

Weight: the average weight of paulownia wood is 208-282 kilograms per 1 cubic meter. Paulownia wood is almost four times lighter than oak at 850 kg per 1 cubic meter and half of pine wood at 482 kg per 1 cubic meter.

Strength: Paulownia has the highest strength-to-weight ratio of any wood species. Paulownia wood is resistant to load and deformation due to moisture.

Stability: Pavlonia wood takes at least 30 days to dry in the open air. The wood can be dried for 24 hours at high temperature in drying ovens until the moisture content in the wood reaches 10-12%. Wood raw materials have a relative shrinkage of 2.2% in drying and 4% in length [9-11].

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The trunk and flowering parts of the paulownia tree:



Figure 1. 3 and 5-year plantation of paulownia tree.

Macroscopic structure of paulownia tree: the bark is gray-brown, rather smooth, without cracks. The color of the wood is grayish yellow. The wood is straight-grained, straight fibers and texture with bright and expressive beautiful patterns of grains, shiny, light, odorless. The smoothness of the wood and the absence of knots indicate the quality of the wood material.

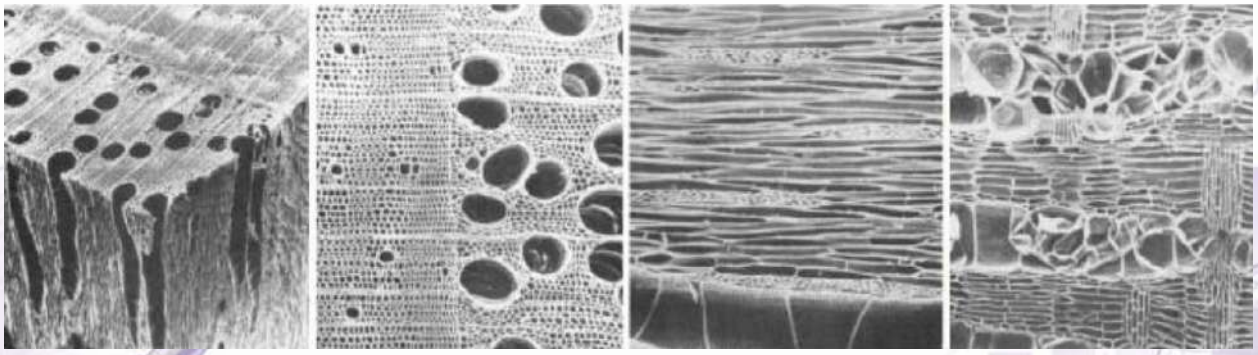
Microscopic structure:

1. Fibers: in cross-sectional holes, round or elliptical. The difference in fiber sizes and three to five perforations between early and late wood; with a maximum deviation of about ten times. The fibers are mostly single, sometimes circular, and the outer layer is smaller in size.

2. Nuclear rays are mostly homogeneous, sometimes heterogeneous, a few are spindle-shaped.

3. Parenchyma cells are well developed, there are tracheids, which are not found in all wood, hardwoods, for example, in oak, in the late layering zone throughout the year.

4. Wood fiber cells are present in growth rings at an early stage of development. Wood fibers are arranged in vertical rows, the cell wall is less than 3 microns thick, and the average length is 550-1700 microns.



1 **2** **3** **4**

Figure 2. Microscopic structure of paulownia wood.

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Due to its fast growth and large leaves, the paulownia tree absorbs a lot of CO_2 carbon dioxide and releases a lot of oxygen.

In the results of our study, the average value of the length of the fibers is 0.905 mm, the average fiber width is 34.59 μm, the average thickness is 26.80 μm, and the cell wall thickness is 3.89 μm.

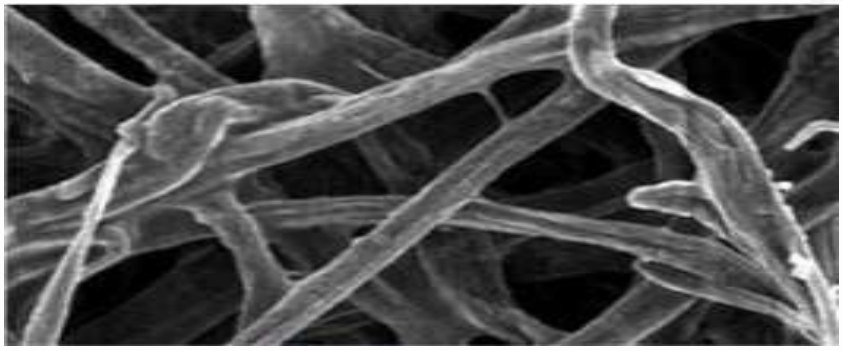


Figure 3. Microscopic structure of paulownia wood.

The coefficient of elasticity of paulownia fibers is included in the group of elastic fibers. The flexibility coefficient of paulownia fibers is 75.96%.

Cross section of paulownia under microscopic magnification:

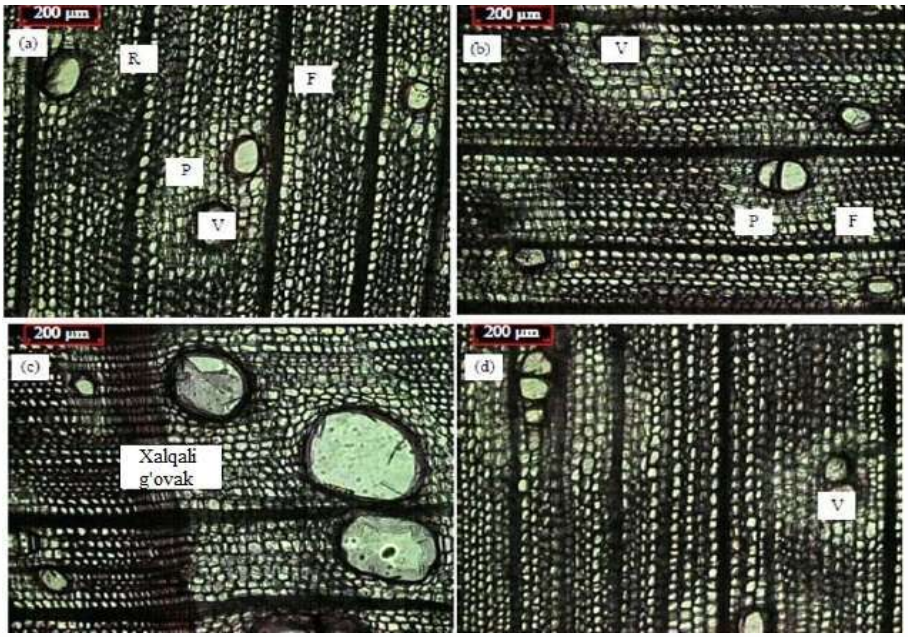


Figure 4. (a and b) - small pores, (c) - compression of fibers, (d) - several large pores, F: proteins, P: parenchyma, R: rays, V: vessels.

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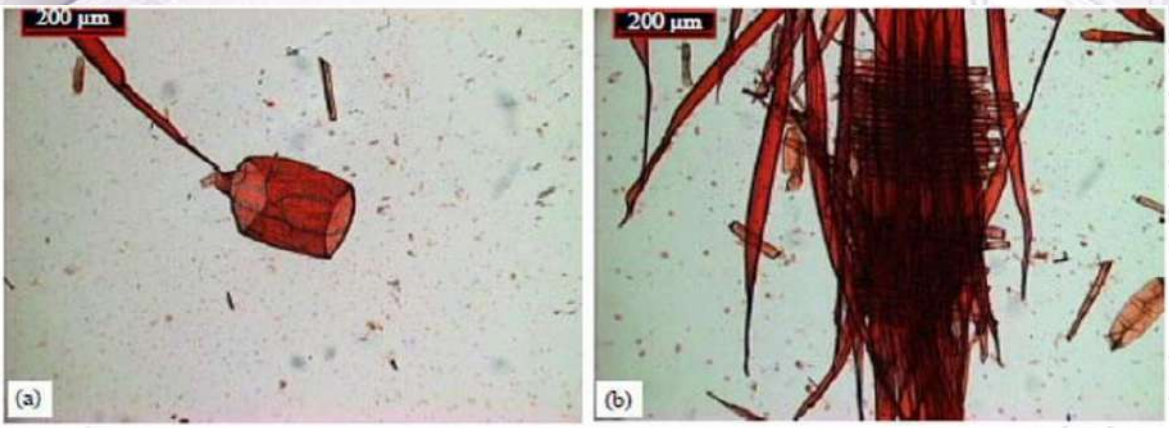


Figure 5. (a) – vessel sample maceration, (b) – radial section, F: fibers, R: rays.

Paulownia wood fibers are not as dense as other dense woods. As you can see in the picture above, the fiber morphology of paulownia wood is good. Paper is a good raw material for manufacturing products. Paulownia tree replaces 35-40-year-old pine with a girth of 50-60 cm and a height of 12-15 m.

Currently, in countries with developed cellulose industry, various researches are being conducted to reduce the participation of factors that cause various destructive conditions in the process of extracting cellulose from various plants containing natural polymers. Because the quality indicators of the obtained cellulose are required to be at a level that allows for its wide use in the future. Taking into account the above points, some simplifications were made in the process of obtaining cellulose from the perennial plant paulownia tree. The plant stem was first cut into small pieces and chemically processed under special laboratory conditions [4].

METHODICAL PART. Propagation of the paulownia plant is underway, it is a fast-growing tree that is used as a building material. In order to determine the suitability of the paulownia plant for chemical processing, individual parts (trunk, branches, roots, bark) were studied.

The results of the analysis of the components of paulownia (Table 1) show that the most valued component of wood - cellulose is present in the largest amount in the trunk of the tree and is 45.5%, while the least amount of cellulose is present in the bark (24.5%).

Table 1

The amount of cellulose and other components in the components of paulownia

№	Components	Body	Horns	Roots	Bark
1	Cellulose, %	45,5	37,2	39,1	24,5
2	Lignin, %	21,8	18,7	19,2	17,1
3	Ash content,%	1,71	1,53	1,71	4,6

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4	Moisture,%	18,3	18.5	18,2	17,5
5	Extractable substances,%	3,21	4,1	5,6	4,7

Table 1 shows that the branches and roots of paulownia can be used as secondary raw materials for chemical processing, as they contain up to 37.2 and 39.1%, respectively, that is, only 6-8% less cellulose than the body. will be available. Lignin, the second chemical component of paulownia, increases with decreasing cellulose content. 21.8, 18.7, 19.2 and 17.1% of lignin were found in the trunk, branches, roots and bark, respectively. It is desirable to use paulownia bark with the least amount of lignin to obtain fibrous semi-products. The remaining components are valuable secondary resources for chemical processing to extract cellulose.

From paulownia wood, cellulose is obtained by first hydrolysis and then alkali treatment. For the chemical treatment to be effective, the paulownia fiber is cut and crushed in 0.5-1 cm size. Then 100 g is taken out, put in a glass and 500 ml of water is poured into it. The mixture is boiled for 4 hours, extracted and filtered to separate the pulp. After the mass is separated from the liquid, it is hydrolyzed in a 3% nitric acid solution for 60 minutes, then it is washed to pH 6.5...8.5 and boiled with 5% sodium alkali to separate the pulp from lignin, polysaccharides and fatty substances. After washing the obtained cellulose to pH 9...9.5, it is bleached with hydrogen peroxide solution. Then the mass is washed and bleached cellulose is dried in a drying cabinet. In order to determine the optimal conditions for the extraction of cellulose from the paulownia fiber, it was cooked in 5% alkali for different times (table 2).

Table 2

Effect of pavlonia cooking time on cellulose content

Time, hours	Cellulose, %	Lignin, %	Polysaccharides, %	Ash content, %	Tar and oils, %	Water soluble substances, %
2	39,5	23,8	37,1	1.92	4,7	9,1
3	42.4	22,1	36,2	1.85	4,9	9,8
4	44.1	21,5	35,5	1.71	2,6	10,6
5	45.5	20,7	34,1	1.63	4,6	10,1

According to the results of the experiments presented in table 2, the most favorable conditions for baking pavlonia dough are as follows:

1. Extraction in water - boiling for 60 minutes.
2. Hydrolysis in 3% nitric acid - 2 hours, temperature - 110ºC.

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3. Boiling in 5% alkali at 110°C for 3 hours to remove impurities from cellulose.

In the experiment according to table 2, the productivity of cellulose is 39.5-45.5%, the amount of lignin is 23.8-20.7%, the amount of polysaccharides is 37.1-34.1%, the amount of ash is 1.92-1.63%, the amount of tar and oil is 4.7-4.6%, and water-soluble substances are 9.1 - made up 10.1%. In order to determine the optimal conditions for the extraction of cellulose from the paulownia fiber, it is cooked in different concentrations of alkali for 6 hours (table 3).

Table 3

Quality indicators of cellulose obtained from 3- and 5-year-old paulownia trees

№	NaOH, %	Boiling τ, hours	Temperature, °C	Quality indicators of cellulose							
				Cellulose product, %	Whiteness level,	Humidity, %	Lignin, %	Ash content, %	Viscosity, cPs	α – cellulose, %	*DP
3 years old											
1	2.5	6	170	37,8	61,3	3.2	23,9	4.83	7,1	61.5	351
2	3.5	6	170	40.1	71,5	3.6	27,5	3.65	9,3	68.3	376
3	**5.0**	**6**	**170**	**43.6**	**87,2**	**3.5**	**29,1**	**3.51**	**11,6**	**70,1**	**410**
4	5.5	6	170	45.3	91,4	3.3	30,2	3.32	12,4	74.6	451
5 years old											
1	2.5	6	170	39,5	65,7	3.4	21,8	3.92	19,4	73.2	1105
2	3.5	6	170	42.4	76,4	3.6	22,1	2.75	21,5	85.4	1069
3	**5.0**	**6**	**170**	**46.1**	**89,6**	**3.7**	**20,7**	**2.51**	**23,2**	**87.1**	**1025**
4	5.5	6	170	48.3	93,1	3.5	23,2	2.27	24,1	88.5	957

* DP – Degree of polymerization

In table 3, in order to determine the optimal concentration of alkali solution for extracting cellulose from the composition of 3 and 5-year-old raw materials, it was boiled for 6 hours in its 2.5, 3.5, 5.0, 5.5% solution and the optimal conditions were determined (Table 3). It can be observed from the table that certain properties of cellulose produced under the influence of different alkali concentrations have different indicators. At the alkali concentration of 5.0%, the 3-year paulownia cellulose content increased to 43.6%, α-cellulose to 70.1%, whiteness to 87.2%, lignin to 29.1%, ash to 3.51%, viscosity to 11.6 and polymerization degree to In 410 and 5-year-old paulownia cellulose, the amount of cellulose is 46.1%, α-cellulose is 87.1%, whiteness is 89.6%, lignin is 20.7%, ash is 2.51%, viscosity is 23.2, and the degree of polymerization is 1025. it became known in the experiment.

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CONCLUSION. Experiments were conducted in the process of processing pavlonia plant, and it was found that cellulose and its derivatives, as well as paper products, can be produced with high-quality products in determining the quality indicators of raw materials.

1. Microscopic structure of paulownia wood, round or elliptical structures in cross-section of fibers, growth rings in the initial stage, thickness of cell wall, their sizes were thoroughly studied;

2. Cellulose extraction from the paulownia tree, its optimal conditions were thoroughly studied;

3. The main quality indicators were determined from the cellulose of three- and five-year-old paulownia trees;

4. It is recommended in the chemical industry and various paper products production industries to obtain various esters from the cellulose obtained from the paulownia tree.

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