PRE-PREPARATION OF SOFTWOOD BARK FOR BIOCONVERSION

Mamaeva O.O., Isaeva E.V.

Reshetnev Siberian State University of Science and Technology 31, Krasnoyarskii Rabochii Prospect, Krasnoyarsk 660000 Russian Federation

It is known that by-products (waste) of wood processing (bark, humpback, slats, cutting boards, cutting out defective places, sawdust, shavings, etc.) account for up to 50%. Of the total amount of wood waste generated, only 60-65% is used as secondary raw materials, the rest of the waste is dumped into dumps [1].

For example, among all the listed types of waste, bark occupies the first place in terms of volume (from 10 to 14% of the total received volume of pure wood, which is more than 100 thousand m3 per year). To solve this problem, some plants use bark as fuel (Kotlas, Svetogorsky pulp and paper mill) [2]. The processing of bark into fuel briquettes, the production of furfural, fertilizers and other products is much more difficult from a technological point of view, so some enterprises are forced to store bark on their own territory or export it to landfills, which negatively affects the environment. The most relevant way of processing bark at the present time may be bioconversion. For this purpose, both macro- and microscopic fungi are used.

It is known that the reactivity of the bark of conifers is relatively low. It is possible to solve this problem in the presence of effective pretreatment methods, the main purpose of which is to destroy the crystalline highly ordered structure of cellulose and/or remove lignin. At the same time, there is an increase in the surface of cellulose available to the molecules of fungal enzymes. Consequently, the degree of utilization of raw materials and the yield of the product increases, which can lead to a reduction in the duration of the bioconversion process.

There are several methods of pre-preparation of plant raw materials: physical, chemical, physicochemical, biological.

Thus, the purpose of this work was to study the effect of pre-preparation of coniferous bark on the process of bioconversion, in particular on the sporulation of fungi of the genus *Trichoderma*.

The raw material for the bioconversion was the waste of the Torzhok wood processing plant (a mixture of softwood bark). The size of the fractions of the initial crust was 7-10 mm.

Several methods of pre-preparation of the bark for bioconversion were used:

1. Chemical. The bark was extracted with a 1% solution of monoethanolamine (MEA) for 5 hours to extract extractive substances with dual properties. These substances can be used independently [3].

2. Physical (mechanical). For this method, hydrodynamic activation (treatment) of the crust in an aqueous medium was used for 30 minutes, which was carried out on a cavitation hydro-impact dispersant: the rotor radius is 277 mm, the rotation speed is 3000 rpm, the productivity is 25 m^3/h, the dry matter content in the suspension is up to 10% by weight [4].

3. Chemical and physical. In this case, the first and second methods were used sequentially.

Salts $(NH_4)_2SO_4$ and Na_2HPO_4 were introduced into the initial and treated bark in amounts of 1.0 and 0.5 g/l, respectively, the moisture content of the raw material was 65-70%. Further, the raw materials were subjected to deep sterilization at 0.1 MPa (1 atm) several times with an interval of 1 day.

The strain K6-15 Trichoderma spp was used as a biodestructor. Fungi of the genus Trichoderma are used in agriculture as plant growth stimulators and biocontrol agents for pathogenic microorganisms and plants [5].

The sowing of the substrates was carried out by a spore suspension of the fungus with a titer of $1 \cdot 10^6$ spores per 1 g of substrate. The crops were incubated in a thermostat at (28 ± 2) °C for 19 days. The titer of the spores was counted in Goryaev's cell. The decrease in the mass of the substrate after biodestruction was determined by the weight method in relation to the initial substrate before biodestruction.

It was found that the maximum titer of spores ($1.35 \cdot 10^9$ spores/g) and a decrease in the mass of the substrate (24.9%) were observed on the solid residue of the bark (odubine) after extraction with 1% MEA solution. The high loss of mass (the degree of utilization of raw materials) indicates the effective effect of the enzymatic complex of the fungus on the substrate, i.e. when using this method of pre-preparation, the availability of the lignocellulose complex increases to the action of the enzymatic system K6-15 *Trichoderma* spp. In addition, the residual content of MEA in the substrate can serve as an additional source of carbon and nitrogen for fungi.

On the bark subjected to hydrodynamic activation (substrate 3), the titer of fungal spores and weight loss decrease by 22% compared to the original bark (substrate 1). When cultivating K6-15 on the bark after the combined pretreatment method (substrate 4), these indicators were significantly lower (by 49%) than on the solid residue after extraction with 1% MEA solution (substrate 2), but higher than on substrate 3. The titer of spores was $0.68 \cdot 10^9$ spores/g, weight loss – 12.7%. It is known from the literature that the processing of plant raw materials in hydrodynamic cavitators is a more effective way (in comparison with the chemical method) to increase the reactivity of raw materials (by increasing the number of highly reactive functional groups) and increasing the active surface of substrate particles for the enzyme system of the fungus. In this case, a decrease in spore formation and the degree of transformation of the substrate is associated with a decrease in the size of the crust particles after hydrodynamic treatment, which led to the traceability of the substrate.

Thus, it was found that a promising method of preparing the bark for bioconversion with the K6-15 strain of *Trichoderma* spp. it is an extraction with a 1% solution of monoethanolamine for 5 hours.

This work was carried out under the State Assignment issued by the Ministry of Education and Science of Russia for the project: “Technology and Equipment for the Plant Biomass Chemical Processing” by the Plant Material Deep Conversion Laboratory (Subject No. FEFE-2020-0016).

REFERENCES

1. https://lesprominform.ru/jarticles.html?id=2640 (accessed: 04/22/2023).

2.https://lesprominform.ru/jarticles.html?id=3528#:~:text=Bark%20 is%20lva%20dole%20 waste%2C,100%20tysyach%20m3%20b%20god (date of circulation: 04/22/2023).

3. The effect of pretreatment on the component composition of the bark of coniferous species / V. S. Fedorov, T. V. Ryazanova, O. O. Mamaeva [et al.] // Topical issues of chemical Technologies and environmental protection : Collection of materials of the IX All-Russian Conference dedicated to the 55th anniversary of the I.N. Ulyanov Chuvash State University. Cheboksary: I.N. Ulyanov Chuvash State University, 2022. pp. 34-35.

4. Formation of the structure of low-density plates from hydrodynamically activated soft woodworking waste / V. N. Ermolin, M. A. Bayandin, S. N. Kazitsin [et al.] // Lesnoy zhurnal 2019. 5. pp. 148-157

5. Bondar P. N., Sadykova V. S. The use of waste from the woodworking industry to create biological products based on fungi of the genus *Trichoderma* // Coniferous forest zone. 2015. Vol. 33, no. 5-6. pp. 286-290.