# APPLICATION OF OXIDATIVE-ORGANOSOLVENT COOKING METHOD FOR OBTAINING CELLULOSE FROM PLANT STALKS

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Different technological methods are used in extracting cellulose from plant stalks, including hydrothermal, chemical (alkaline, sulfate, sulfite), organosolv, and biological approaches. The organosolv method stands out due to its benefits: good separation, low temperatures, the ability to reprocess lignin, and ecological safety. This method typically uses ethanol, acetone, methanol, organic acids, or combinations of them as a solvent. This softens the chemical bonds between lignin, hemicellulose, and cellulose, allowing for the separation of cellulose with almost no contamination.

Cellulose from annual plants gotten through the organosolv method is a good raw material for making paper, biocomposites, biofuels, biosorbents, biopolymers, and nanocellulose. Also, this technology allows for the economically efficient recycling of industrial waste and agricultural residue.

So, this study aims to make a technology for extracting high-purity cellulose from annual plant stalks using the organosolv method and to study its physical and chemical properties. The goal is to create an ecologically sustainable, energy-saving, and economically sound technological solution.

The study employed an organosolv cooking method. In oxidative-organosolv cooking, peroxy compounds, such as peracetic acid (CH3CO3H) and hydrogen peroxide, serve as the main active cooking agents. Because peracetic acid has strong oxidizing properties, it breaks down the aromatic structure of lignin, based on the reaction: Lignin+CH3CO3H→ breakdown products+H2O+CH3COOH. This allows cellulose fibers to be easily freed, streamlining cellulose separation. These compounds are susceptible to heavy and transition metal ions, which act as catalysts for their decomposition. To improve the use of peroxide compounds, stabilizers from the class of organophosphonates are added to the cooking composition.

During cooking, temperature and pressure were kept constant. After the reaction, the mixture was cooled and separated by vacuum filtration. The residue (cellulose) was rinsed with hot water and then with 70% ethanol. Next, it was processed in 0.1 M NaOH solution for 30 minutes to remove any remaining traces of lignin. The purified cellulose was rinsed with distilled water to a neutral pH and dried at 60°C.

Initially, the impact of peracetic acid consumption on the delignification process was explored to reach the level of delignification and get quality technical cellulose. Data are shown in Table 1.

**Table 1**

**Dependence of product yield on cooking conditions in obtaining technical cellulose from Miscanthus**

| NUK consumption, g/g | Organo-phosphonate, % | Yield of technical cellulose, %: | | Lignin, % | Degree of bleaching, % |
|---|---|---|---|---|---|
| | | After the final stage | After the initial stage | | |
| 0,1 | - | 77,5 | 49,7 | 3,8 | 75,0 |
| | 0,01 | 78,4 | 51,3 | 3,7 | 74,0 |
| 0,2 | - | 87,7 | 57,7 | 3,7 | 76,0 |
| | 0,01 | 88,5 | 56,9 | 3,6 | 80,0 |
| 0,3 | - | 92,2 | 62,4 | 3,7 | 85,5 |
| | 0,01 | 94,5 | 62,8 | 3,7 | 88,5 |
| 0,4 | - | 88,8 | 58,4 | 3,5 | 86,4 |
| | 0,01 | 89,7 | 57,5 | 3,3 | 90,1 |
| 0,7 | - | 76,4 | 50,6 | 3,5 | 90,3 |
| | 0,01 | 78,7 | 51,9 | 3,2 | 94,1 |

Analysis of the data in Table 1 suggests that the best results occur when the consumption of NUK is 0.3-0.4 g/g. The selective action of the cooking composition rises considerably with the application of organophosphonate.

Under cooking conditions carried out at nearly the same output level, but without prior separation stages, unevenly cooked technical cellulose with a low degree of bleaching (less than 60 %) is obtained.

The kinetics of the delignification process were studied at a NUK consumption rate of 0.3-0.4 g/g. The kinetics of the cooking process were examined under isothermal conditions. Initial raw materials contained about 63 % holocellulose, and the oxidizing-organosolvent method was observed to retain

94.5 % of the holocellulose complex, when the yield of technical cellulose was 62.8 %.

This work details a method for extracting technical cellulose from annual lignocellulosic plants—rice straw, wheat straw, and miscanthus (Miscanthus sinensis)—using an organosolvent approach. The aim of this work is to refine an environmentally sound, energy-saving, and cost-suitable oxidative-organosolvent pulping process. Peracetic acid (CH3CO3H) and hydrogen peroxide (H2O2) serve as the main delignification agents. Peracetic acid breaks down the aromatic structure of lignin, while hydrogen peroxide works to keep balance. Under the right conditions (0.3-0.4 g/g of peracetic acid, with 0.01% organophosphonate stabilizer), technical cellulose yield reached 57-60%, with a brightness level of up to 90%. The use of organophosphonate increased the stability of the peroxide system and strengthened the selective action of the delignification. The resulting cellulose was pure, bleached, and mechanically strong, making it promising for paper, biocomposites, biosorbents, nanocellulose, and biofuel production. This oxidative-organosolvent method is a sustainable and environmentally sound way to get technical cellulose from annual plants.