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Methods for Isolation of Lignin from Plant Tissues

Mohamed Ammar*

Material Environment and Energy Laboratory (UR14ES26), Faculty of Sciences of Gafsa, University of Gafsa, Tunisia

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***Corresponding author:** Mohamed Ammar, Material Environment and Energy Laboratory (UR14ES26), Faculty of Sciences of Gafsa, University of Gafsa, Tunisia, Email: ammarmohamed10@yahoo.fr

Abstract

Isolation methods depend on the fibers nature that is used as the source of the bio-polymers. The reaction conditions and severity has an important place in the whole isolation process. Extent of needed condition depends on the purity of the obtained polymers. In this study, different lignin extraction methods are presented and discussed.

Klason Lignin

Wood meal is stirred at room temperature and hydrolysis with 64 to 75% sulfuric acid. The Klason lignin is obtained after removing the polysaccharides, and refluxed with dilute acid; then the Klason lignin or sulfuric acid lignin is filtered, dried, and weighed.

Kraft Process

Black liquor is generated in the cooking process as the white liquor dissolves the lignin and other organic compounds in the wood. Kraft or Sulfate cooking is the most commonly used pulp production method. Kraft process uses white liquor containing mainly the active chemicals, a mixture of sodium hydroxide (NaOH) and sodium sulfide (Na2S) as the main cooking chemicals. The sulfite process is characterized by its high flexibility compared to the Kraft process, which is a very uniform method, which can be carried out only with highly alkaline cooking liquor [1,2].

Milox Process

The extraction involves the use of peroxyformic and formic acids. This technique consists in forming peroxyformic acid by reacting formic acid with hydrogen peroxide. The protic character of formic acid is sufficient to break the bonds between lignin and polysaccharides. The implementation of this method allows the separation of lignin at 107 °C, under atmospheric pressure during 4 to 5 hours. Then, a bleaching step is carried out to eliminate the residual lignin from the cellulose fibers. Finally, a filtration step is performed in order to obtain the black liquor solutions, from which lignin samples were precipitated.

Acetosolv Process

The Acetosolv method consists in extracting lignin by treating the raw material by acetic acid (90%) containing 0.1% hydrochloric acid. As described in the case of the Milox process, peroxyacetic acid is also formed in this process. The reaction is conducted under atmospheric pressure at 80 °C during 5 hours. The prepared lignin is also precipitated in water and the experiment was repeated at least three times.

CIMV Process

CIMV is derived from the Formacell process, which uses acetic acid/formic acid and water in various ratios at high temperature and under different pressures. The difference between this process and the ones described before is that this method can offer a high lignin quantity. The CIMV process uses the same reagent as Formacell process at low temperature. The lignin extraction is accomplished at a temperature range between 105 and 110 °C, under atmospheric pressure, during 3h, using a 30/55/15 v/v/v ratio of acetic acid/formic acid/water. In fact, in this process, acetic acid is a solvent for lignin and hemicelluloses, whereas formic acid is the chemical agent that plays the role of catalyst to break the ether and ester bonds between polysaccharide and lignin. The addition of water allows the elimination of hemicelluloses and lignin.

Discussion

Many solvent are used to characterize lignin such as DMSO, Dioxan, and 0.1M NaOH. Several analytic techniques and instruments were used, such as ultraviolet-visible (UV-Vis) spectroscopy and Fourier transform infrared spectroscopy

(FTIR), in order to identify the purity of samples. Liquid NMR is used to found lignin structure which can be built by H, G or S unit. klason lignin is used as a reference for calculating the percentage of delignification. It is assumed as the total yield of lignin. Generally the yield of recovered lignin is high using the Kraft method with low purity (low absorbance at 280nm). Organosolv lignin is purer and more reactive than kraft lignin with low modified structure. To avoid the condensation of lignin it must be dried at a temperature of 50 °C.

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