



## LIGNOCELLULOSIC RESIDUES AS CARRIES FOR DRUG DELIVERY

V. Halysh<sup>1,2</sup>, O. Sevastyanova<sup>3,4</sup>

<sup>1</sup> - Igor Sikorsky Kyiv Polytechnic Institute,  
Peremogy Avenu 37, Kyiv, 03056, Ukraine

<sup>2</sup> - O.O. Chuiko Institute of Surface Chemistry, National Academy of Sciences of Ukraine  
General Naumov St.17, Kyiv, 03164, Ukraine

<sup>3</sup> - Department of Fiber and Polymer Technology, KTH Royal Institute of Technology  
Teknikringen 56-58, SE-100 44 Stockholm, Sweden

<sup>4</sup> - Wallenberg Wood Science Center, KTH Royal Institute of Technology  
Teknikringen 56-58, SE-100 44 Stockholm, Sweden

**e-mail:** v.galysh@gmail.com

Non-steroidal anti-inflammatory drugs are a special group of drugs which can cause mucosal damage of the stomach. This problem can be solved through immobilization of drugs on various carriers for more efficient and safe drug delivery. Natural biodegradable polymers obtained from different sources like proteins, carbohydrates and chemically modified carbohydrates can be used among others for this purpose.

Plant material is the mixture of polysaccharides and biopolymers of aromatic nature. Cellulose is a linear homopolymer consisting of  $\beta(1\rightarrow4)$  linked D-glucose units. It is the main constituent of fibers and one of the most abundant organic polymers in nature. Lignin is a heteropolymer of aromatic nature with highly complex structure. It is one of the most abundant aromatic natural polymers. Due to its aromatic structure, lignin can be regarded as a promising source of valuable products. Lignin is one of the main constituents after cellulose in plant materials and can be separated from cellulose by different pulping processes or by acid hydrolysis. Due to the presence of various functional groups in cellulose and lignin, these biopolymers exhibit a high sorption ability. Lignocellulosic complexes consisting of lignin, hemicellulose and cellulose in various proportions can potentially be considered as an effective carrier of pharmaceuticals drug in the composite delivery systems [1].

Vegetable residues of agriculture and food industry can be a great source of pure lignin and cellulose or the lignocellulose complexes with unique chemical and physical properties [2]. Sugarcane is an important crop in tropical and subtropical countries, and bagasse and straw are by-products of sugarcane industry. Different methods for their utilization have been proposed, for example, bioconversion [3] or for pulp production [4]. Another way of prospective processing of sugarcane residues is their chemical modification with the aim of obtaining effective sorbents of different composition and structure for uses in ecology and medicine.

The aim of the work was to study the structural, morphological and sorption properties of lignin, cellulose and lignocellulose, derived from sugarcane bagasse and straw by means of hydrolysis and delignification, as potential components for drug delivery system.

The results of the study showed that bagasse (42.1% cellulose, 33.8% hemicellulose, 21.4% lignin, 0.8% extractives, 3% ash) and straw (37.2% cellulose, 30.6% hemicellulose, 19.6% lignin, 4.3% extractives, 7.8% ash) differs from each other by chemical composition. The contents of cellulose and hemicelluloses in sugarcane straw lower than in sugarcane bagasse. The bagasse is characterized by the presence of low portion of extractives (resins, wax and fats), while the lignin content is greater

in sugarcane bagasse. In order to isolate lignin, cellulose and lignocelluloses, sulphuric acid hydrolysis, hydrogen peroxide delignification in acetic acid and acetic acid hydrolysis [5], respectively, were used.

The content of the main components in materials obtained is given in Table 1. The density of the sugarcane biomasses and biopolymers as well as their specific surface area and adsorption pore volume are given in Table 2. At original moisture content 8%, studied samples differed from each other in bulk and true densities. Sugarcane straw shows higher densities in comparison with bagasse. Lignin samples have greater bulk and true density as compared to other materials. The increase in specific surface area and adsorption pore volume after lignin obtaining was observed. Both samples of cellulose and lignocellulose from straw have greater pore structure if compare to initial material. The greater ash content is characteristic for all samples derived from straw.

**Table 1.**

**Structural characterization of sugarcane bagasse-derived materials**

Materials	Parameters					
	Lignin/cellulose content, %	Bulk density, g/cm <sup>3</sup>	True density, g/cm <sup>3</sup>	Specific surface area, m <sup>2</sup> /g	Adsorption pore volume, cm <sup>3</sup> /g	Ash, %
Sugarcane bagasse	21.4/42.1	0.049	0.096	1.35	0.08	2.3
Lignin from bagasse	90.5/3	0.121	0.412	2.98	0.19	6.5
Cellulose from bagasse	3.03/67.3	0.048	0.069	1.25	0.15	2.5
Lignocellulose from bagasse	29/34.3	0.116	0.383	1.23	0.11	1.27
Sugarcane straw	19.6/37.2	0.087	0.119	1.93	0.05	7.8
Lignin from straw	81.8/1	0.141	0.159	6.68	0.24	17.2
Cellulose from straw	8.6/57.5	0.038	0.138	5.37	0.13	9.7
Lignocellulose from straw	27.7/30.3	0.124	0.487	2.68	0.18	6.06

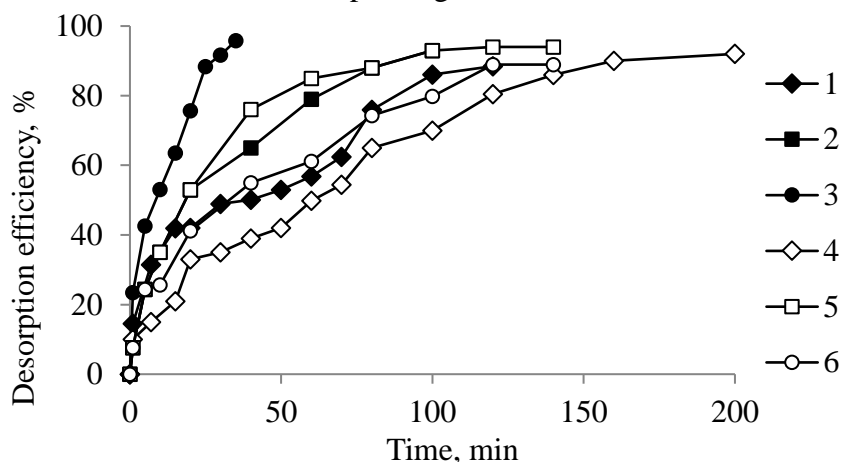
The sorption ability of biopolymers from sugarcane residues towards sodium diclofenac was investigated in batch experiments with the use of model solutions with concentrations 32 mg/l. Experiments were carried out during 24 h at 25 °C. The results are shown in Table 2. According to the data obtained, the values of sodium diclofenac sorption efficiency correlate with the values of the specific surface area and pore volume for corresponding materials. Lignin from sugarcane straw, which shows greater porosity, has the greater sorption properties.

**Table 2.**

**Sorption properties of biopolymers from sugarcane residue**

Indicator	Lignin from bagasse	Cellulose from bagasse	Lignocellulose from bagasse	Lignin from straw	Cellulose from straw	Lignocellulose from straw
Efficiency of sodium diclofenac sorption, %	36.5	15.6	2.13	85.8	21.5	44.4

The possibility of use of biopolymers as carriers of sodium diclofenac was studied. With this purpose, plant polymers were impregnated with an alcoholic solution of sodium diclofenac and desorption process was investigated. The kinetics of the release of the drug from the resulting composites indicate the direct dependence of the efficiency of the sodium diclofenac desorption on the porosity of the carrier (Fig. 1). Lignin sample from sugarcane straw has longer period of drug release, that indicates the obtained effect of prolongation.



**Figure. Sodium diclofenac efficiency desorption from the volume of lignin (1), cellulose (2) and lignocellulose (3) from sugarcane bagasse and lignin (4), cellulose (5) and lignocellulose (6) from sugarcane straw**

These results may serve as a basis for the development of efficient methods for the utilization of sugarcane residues in pharmaceutical industry.

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