«Carbonization products in $D$-glucose-$p$-toluidine system as sorbents of carbohydrate caramels from aqueous solutions»

Igor S. Cherepanov
Problem statement:

The products of non-enzymatic staining reactions in carbohydrate-based systems have important practical applications in food and pharmaceutical industries, and the problem of their sorption binding is still urgent. Having an intense colour, melanoidins and caramel, falling into rivers, create obstacles to the passage of sunlight, which leads to the degradation of aquatic ecosystems.

Problem solution:

Carbonization products in monosaccharide – p-toluidine systems, which are characterized by a higher carbon content in comparison with the initial carbohydrates and functionalization close to that of natural carbon-saturated materials, which makes them promising as adsorbents, especially in relation to close to the nature of adsorbates.

Aim of study:

In present work, we studied the possibility of using carbonization products based on D-glucose as available reagents for the sorption of components of carbohydrate (D-glucose, D-Lactose) caramel solutions synthesized in water-ethanol media.
Solution methods

Experimental methods:
- Synthetic methods of organic chemistry
- IR-Fourier transform spectroscopy
- UV-Vis spectroscopy
- Elemental analysis
- Absorption experiments

<table>
<thead>
<tr>
<th>Structure elements</th>
<th>Functions</th>
<th>Aromatic component</th>
<th>Aliphatic component</th>
</tr>
</thead>
<tbody>
<tr>
<td>The position of the spectral bands and</td>
<td>1720 cm⁻¹ (ν\text{C=O})</td>
<td>1510, 1580, 1620 cm⁻¹</td>
<td>1000-1100 cm⁻¹</td>
</tr>
<tr>
<td>their assignment</td>
<td>1190, 1210, 1260 cm⁻¹</td>
<td>750, 815, 870 cm⁻¹ (γ\text{C-H})</td>
<td>(ν\text{C} + δ\text{CO} + ν\text{CC} + ν\text{as ring})</td>
</tr>
<tr>
<td></td>
<td>3400 cm⁻¹ (ν\text{O-H, N-H})</td>
<td>3030 cm⁻¹ (ν\text{C-H})</td>
<td>2855, 2922, 2950 cm⁻¹ (ν\text{C-H})</td>
</tr>
</tbody>
</table>

Table 1. Assignment of the main bands in the IR Fourier spectra to the elements of the structure of carbonation products.

Figure 1. FTIR spectra of carbonization products prior to adsorption experiments (1); after keeping in solution caramel based on D-glucose (2); after keeping in solution caramel based on D-lactose (3) (on the left); Fragments of the FTIR spectra of carbonation products prior to adsorption experiments (1A, 1B); after keeping in solution caramels based on D-lactose (2A), D-glucose (2B); Difference FTIR spectra (3A, 3B) (on the right)
Conclusions

Based on the data obtained, it can be argued that the carbonization products synthesized in the D-glucose-p-toluidine systems are capable of surface absorption of the carbonyl components of carbohydrate caramels from aqueous solutions.

The research results are promising for the development of methods for the synthesis of carbon-saturated products, sorption-active with respect to substances of carbohydrate nature, which is of interest for the food and pharmaceutical industries.

Data obtained analysis:

- The initial spectra show the presence of a weak shoulder in the 1720 cm\(^{-1}\) region (figure 1, left position), corresponding to the stretching vibrations of the carbonyl groups and slightly differing in integral intensity during the transition from the initial products to the products after adsorption.

- Difference spectra 3A and 3B (figure 1, right position, presented for convenience of comparison as transmission spectra) in the corresponding pairs 2A-1A and 2B-1B show a difference peak at 1720 cm\(^{-1}\), which indicates a higher absorption of the samples after adsorption, indicating on the concentration sorption of carbonyl derivatives from a solution on the surface.

- Since no displacement of peaks in the spectra of materials after adsorption is observed in comparison with the signals of the starting material, it can be assumed that the sorption processes are predominantly physical in nature. In this connection, it can be assumed that the adsorption of mainly low-molecular components of caramels occurs.

- Quantitative processing of difference FTIR spectra with curve approximation with the corresponding sum of Gaussians shows a greater value of the integral intensity of the difference peaks for systems with lactose caramels. The UV spectra of dialysates obtained from the caramels of the complete reaction systems, from the data of which it is clear that the low molecular weight colored products are formed during caramelization to a greater extent in systems based on lactose.
Contacts

Igor S. Cherepanov
Udmurt State University
E-mail: cherchem@mail.ru