Investigation of the Properties of Capsule Shells Based on Pectin

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Abstract

The following properties of pectin were studied: bulk density, viscosity, percentage of insoluble residue content of microvoids, specific volume, specific surface area, characteristic diameter. By micrographs the dynamics of structural changes the structure of the interaction with the solvent was estimated. The dispersion, size, and number of air bubbles in pectin were determined by microphotography with prior freezing of samples in liquid nitrogen. Spectrometric profiles of pectin were obtained. According to the results of spectrometric profile analysis, the mass fraction of chemical elements (oxygen, nitrogen, carbon, sodium, chlorine) was estimated. The microstructure of ARA105 pectin has an average bulk density of 580 g/dm³, its elements are presented in the form of dispersed particles of irregular shape, with a size of 20-250 µm, and its granules are larger than 300 µm. There is sodium and chlorine, in addition to carbon, nitrogen, and oxygen in pectin ARA 105. The share of microvoids and dispersed formations on the surface of the elements is 39.60 and 12.69%, respectively.

Keywords
Pectin; Plant analog; Gelatin; Capsule

Introduction

Among the currently known analogs of pharmaceutical gelatin, natural anionic polysaccharides (pectin, carrageenan, starch) and synthetic (oxidized starch origin) are widely used [1]. In other countries there is a widespread use of alginites, cellulose derivatives, and carboxymethyl cellulose (CMC), as well as various gums [2].

One of the classical plant analogs of gelatin is starch which has been widely used in the food industry [3,4]. The various types of pectin are some of the promising plant gelatin analogs. They are currently used in the food and pharmaceutical industries. Pectins are capable of forming a gel system, characterized by a specific set of physical and chemical properties. Moreover, it was found that pectin has a beneficial effect on the human body, and the resources for the production of pectin are practically unlimited [5,6].

Materials and Methods

The object of this study is pectin ARA 105, a plant analog of pharmaceutical gelatin.

The composition and properties of the plant analogs of pharmaceutical gelatin for the preparation of soft capsules was analyzed. Bulk density, viscosity, percentage of insoluble residue content of microvoids, specific volume, specific surface area, and characteristic diameter were selected as the examined characteristics. The dynamics of structural changes in the interaction with the solvent were assessed by microphotographs [7]. According to the analysis of the spectrometric profile, the weight proportion of the chemical elements (oxygen, nitrogen, carbon, sodium chloride) was assessed.

For the study of plant analogs of pharmaceutical gelatin, the analyzing station JEOL JED-2300 was used, by means of which and according to the X-ray microanalysis method, the spectrometric profiles were obtained, which allowed us to determine the chemical composition of plant analogs of pharmaceutical gelatin [8,9].

Ability to form HDS (foaming capacity) was determined by P. Rebinder (by multiplicity foams) and expressed in percentage. HDS sustainability for certain duration of time was calculated as the ratio of the initial to the final height of HDS and expressed in percentage.

Dispersity of HDS, size, and number of air bubbles was measured by microphotography with a preliminary freezing sample in liquid nitrogen. Treatment results were evaluated according to the procedures set forth in Reference [10,11].

Results and Discussion

Figure 1 shows photomicrographs of pectin ARA 105 pectin at a magnification of 100, 200, and 500 times. From the obtained microphotographs, it follows that the structure of pectin ARA 105 elements comprises dispersed particles of irregular shape, with a size of 20-250 µm, and in some areas there are granules larger than 300 µm (Figure 1a). Their size may vary from a few micrometers to 30-40 µm (Figure 1b). There are crystalline clusters on the surface of the granules (Figure 1c). Bulk density of pectin ARA 105 is 580 g/dm³.

The basic structural element of pectin macromolecules as polysaccharide of plant tissues is galactopyranosyl acid, which includes LD-galakturon. The pectin composition includes neutral carbohydrates, such as galactose and arabinose. The pattern of distribution of ester groups in the pectin macromolecule influences such physical and chemical properties as gelling capability, solubility, and surface activity. The thermodynamic flexibility of pectin macromolecules is largely influenced by the degree of esterification. The solubility of pectin in water can be increased by reducing the molecular weight and increasing the degree of esterification (Figure 2).
Pectins of high degree esterification are capable of gelling in acid medium in the presence of sucrose, whereas pectins with a low degree of esterification with the presence of polyvalent metals salts. Wide dissemination of pectins as structure stabilizers in the confectionery and pharmaceutical industries is due to their physiological inertness and good gelation ability.

Figure 3 shows the spectrometric profile of the component composition of pectin ARA 105. The resulting profile shows three peaks corresponding to carbon, oxygen, and sodium and a sloping area corresponding to nitrogen.

Component composition of pectin ARA 105 is shown in Table 1. The content of carbon and nitrogen is nearly at the same level as in

Pectin exhibits the greatest stability at pH 3-4 (Figure 3). PH deviation from this range tends to reduce the charge density of the pectin macromolecules, and this phenomenon is most expressed when the temperature rises above 50°C.

**Table 1: Component composition of pectin ARA 105**

<table>
<thead>
<tr>
<th>Element</th>
<th>Relative mass, %</th>
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<tbody>
<tr>
<td>Carbon</td>
<td>39.04 ± 0.77</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>32.70 ± 0.59</td>
</tr>
<tr>
<td>Oxygen</td>
<td>43.86 ± 1.33</td>
</tr>
<tr>
<td>Sodium</td>
<td>3.48 ± 0.13</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.13 ± 0.006</td>
</tr>
</tbody>
</table>
konjac gum. Sodium and chlorine in an amount of 3.28 and 0.12%, respectively, are present in the composition of pectin ARA 105 as well as in carboxymethyl cellulose.

According to the micrographs of the resulting pectin ARA 105 structure in Figure 4a, the content of microvoids was defined, and by the photomicrograph in Figure 4c, which is similar to Figure 1c, a mask on the surface of dispersed formations on the surface of the structure elements of the stabilizer was created. The corresponding micrographs obtained and masks are shown in Figure 4.

The content of the microvoids in pectin ARA 105 was 49.60% ± 1.5%, and the content of dispersed formations on the surface of the structure elements of the stabilizer was 13.79% ± 0.8%. It should also be noted that for obtaining the mask shown in Figure 4d, it was necessary to improve the image contrast and the manual correction of certain areas of the mask because of the fact that the required elements in the photomicrograph had uniform color over the entire surface.

Conclusion

Thus, pectin ARA 105 microstructure is characterized by an average bulk density of 580 g/dm³, with its elements presented in the form of dispersed particles of irregular shape, with a size of 20-250 µm, and with its granules larger than 300 µm. Besides carbon, nitrogen, and oxygen in pectin ARA 105, sodium and chlorine are also present. Proportion of microvoids and dispersed formations on the surface of the elements is, respectively, 39.60 and 12.69%.

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References


Figure 4: Results of the fraction determination of microvoids (a, b) and the dispersed entities (c, d) of ARA105 pectin: (a) photomicrograph magnified at 100 times; (b) mask micrograph of (a); (c) a fragment of micrograph; (d) mask micrograph of (c)


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