Analysis of Sodium Alginate Physicochemical Parameters for Obtaining Vegetative Analogue of Pharmaceutical Gelatin

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ABSTRACT

Composition and properties of vegetative analogue of pharmaceutical gelatin for obtaining soft capsules have been analyzed. The following properties of sodium alginate have been studied: bulk density, viscosity, ratio of insoluble residues, content of micro voids, specific volume, specific surface area, and characteristic diameter. Using photomicrography, dynamics of structural changes in course of interaction with the solvent has been assessed. Dispersion, size and quantity of air bubbles in sodium alginate were defined by means of photomicrography with preliminary freezing samples in liquid nitrogen. Spectrometric profiles of sodium alginate were obtained. According to the results of spectrophotometric profile analysis, mass fraction of chemical elements (oxygen, nitrogen, carbon, sodium, chlorine) was estimated.

INTRODUCTION

At present, among currently known analogues of pharmaceutical gelatin, anionic polysaccharides of both natural (pectin, carageenan, starch) and synthetic (oxidized starch) origin are widely used. [1] Alginites, cellulose derivatives, carboxymethylcellulose (CMC), and various gums are widely used abroad. [2]

One of classical vegetative gelatin analogues is starch that has been widely used in food industry for a long time [3, 4]. Pectins of various types may be regarded as most promising vegetative analogs of gelatin. They are currently used in food and pharmaceutical industries. Pectins are capable of forming gel systems characterized by a specific set of physicochemical properties. Moreover, it was found that pectin has a favorable effect on human organism, and pectin manufacturing resources are virtually unlimited [5, 6].

Methods:

Object of study was vegetative analogue of pharmaceutical gelatin: alginate NO4-600.

Composition and properties of vegetative analogue to pharmaceutical gelatin for obtaining soft capsules have been analyzed. The following properties were studied: bulk density, viscosity, ratio of insoluble residues, content of micro voids, specific volume, specific surface area, and characteristic diameter. Using photomicrography, dynamics of structural changes in course of interaction with the solvent has been assessed. According to the results of spectrophotometric profile analysis, mass fraction of chemical elements (oxygen, nitrogen, carbon, sodium, chlorine) was estimated.

In order to investigate the composition of vegetative analogs of pharmaceutical gelatin, the analyzing station JEOL JED-2300 was used for electron probe microanalysis on order to obtain spectrometric profiles that make it possible to determine the chemical composition of vegetative analogs for pharmaceutical gelatin [8, 9].

Ability to form GDS (foaming capacity) was determined using method of P.A. Rebinder (foam expansion method) and shown in percent [10].

GDS Stability for certain duration of time was calculated as the ratio of initial to final GDS height expressed in percent [11].

GDS dispersity, size and quantity of air bubbles were defined by means of photomicrography with preliminary freezing samples in liquid nitrogen. Results were processed according to the procedures described in [11].
Main part:

Fig. 1 shows photomicrograph of sodium alginate NO4-600 at magnifications 100, 200 and 500.

Fig. 1 shows that the structure of sodium alginate NO4 600 elements includes dispersed particles of irregular shapes, sizes ranging from 20 to 250 µm. On their surface there are crystalline formations. Particle shape can be both round and elongated (Fig. 1 (b)). Bulk density of sodium alginate NO4-600 is 600 g/dm3.

By its nature, this structure stabilizer is a sodium salt of alginic acid, or a polysaccharide in brown algae cell walls. Sodium alginate is a linear copolymer of L-guluronic and D-mannuronic acids. The macromolecular chain of sodium alginate contains both homopolymeric blocks and blocks of alternating monomeric particles sequences.

It is worth mentioning that structure stabilizer is a weak polyelectrolyte wherein the degree of ionization depends more on the pH value and dielectric constant of the medium than on temperature. In aqueous systems, macroanion is a durable asymmetric formation.

Salts of alginic acid are soluble in water with alkali metals, and form highly viscous solutions. In certain conditions, sodium alginate can form jelly. Solution of alginic acid salts exhibits stability at a pH between 5 and 10 at room temperature for a long time (Fig. 2).
Fig. 2: Dependence of sodium alginate NO4-600 viscosity on pH value.

Tendency of sodium alginate to self-association is due to containing homopolymer blocks and its charge. In case of significant content of such blocks, the process leads to precipitation with low macromolecule charge. In a case where an alternating sequence of blocks prevails, structure stabilizer is less biased to self-associate. They exhibit good solubility even with pH value below 2, when high ionic strength is present.

Fig. 3 shows the spectrometric profile of sodium alginate NO4-600 component composition.

Component composition of sodium alginate NO4-600 is shown in Table 1. The obtained data show that the distinguishing feature of sodium alginate NO4-600 compared to previously considered structure stabilizers is the presence of calcium and the absence of nitrogen. In sodium alginate NO4-600, oxygen is prevailing (52.91%). Chlorine is characterized by the least content (0.19%).

![Spectrometric profile of sodium alginate NO4-600 component composition.](image)

**Table 1: Sodium alginate NO4-600 component composition.**

<table>
<thead>
<tr>
<th>Element</th>
<th>Relative weight, %</th>
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<tbody>
<tr>
<td>Carbon</td>
<td>37.37±1.12</td>
</tr>
<tr>
<td>Oxygen</td>
<td>52.91±1.58</td>
</tr>
<tr>
<td>Sodium</td>
<td>9.26±0.28</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.19±0.006</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.27±0.01</td>
</tr>
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Fig. 4 shows photographs of micro voids in the structure of sodium alginate NO4-600 obtained by processing photomicrographs from Figs. 4 (a).

By obtained mask (Fig. 4 (b)) the desired content of micro voids was determined, which was 33.79 ±1.1 %.

![Photographs of micro voids.](image)

**Fig. 4: Sodium alginate NO4-600 micro voids: a - photomicrograph at magnification x100; b - mask of photomicrograph shown in Fig. 4.7.4 (a).**

Thus, main elements of sodium alginate NO4-600 structure are dispersed particles of irregular shape with size of 20-250 µm with crystal-like formations on the surface. Sodium alginate NO4 600 contains carbon, oxygen, sodium, chlorine and calcium. By results of mathematical photomicrograph processing, the content of...
micro voids in the structure of the stabilizer is 33.79±1.1 %.

Conclusions:

Thus, pectin 105 ARA micro-structure is characterized by average bulk density of 600 g/dm3. Main elements of sodium alginate NO4-600 structure are dispersed particles of irregular shape with size of 20-250 µm with crystal-like formations on the surface. Sodium alginate NO4 600 contains carbon, oxygen, sodium, chlorine and calcium. By results of mathematical photomicrograph processing, the content of micro voids in the structure of the stabilizer is 33.79±1.1 %.

ACKNOWLEDGEMENTS

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REFERENCES