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Light Transmission Coefficient and the Thickness of Soft Capsule Shells Derived from Plant Analogs of Pharmaceutical Gelatin

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Abstract

The integral light transmission and thickness of the capsule shell from pharmaceutical gelatin and its plant analogs were studied. It was found that sample No. 2 has the maximum shell thickness; its value is 1.378. It entirely consists of gelatin (with only the addition of glycerol as plasticizer and water). Sample No. 8 has the smallest thickness, with the value of 0.592. It consists of kappa-carrageenan, iota-carrageenan, and corn starch. It is proved that the ratio of the integral light transmission is in the same range for all the studied samples of capsule shells, indicating the approximately equal light-transmitting capacity of all sample membranes from plant analogs of pharmaceutical gelatin. However, sample No. 10 was characterized by light transmittance at a longer wavelength of light passing through the shell. This sample was prepared without the addition of gelatin, indicating more light transmittance at the wavelength of transmitted light for pure analogs of pharmaceutical gelatin. Light transmission coefficient is a parameter that does not depend on the concentration and thickness of the capsule shell, and depends only on the wavelength of the transmitted light and on the composition of the shells.

Keywords

Capsule shells; Gelatin; Light transmission; Plant analog

Introduction

Market analysis of encapsulated medicines and biologically active dietary supplements indicates close attention of capsule-manufacturing companies to search for alternatives of the traditionally used gelatin in this area [1]. This trend is based on the laws of development of the global consumer market: economic viability due to cheaper raw materials, consumer demand for the encapsulated pharmaceuticals and dietary supplements with new diverse characteristics that meet a wide range of consumers, including those who do not use animal products for religious and/or behavioral (vegetarians) motives [2]. All the above factors create an urgency of developing technology for the production of capsules based on non-traditional raw materials, which can act as the composition of hydrocolloids of plant origin [3].

One of the classical plant analogs of pharmaceutical gelatin is agar, which is already widely used in the confectionery industry for a significant time. However, the growing shortage of power has caused agar to be replaced with other plant counterparts. Thus, for example, one of the most promising analogs of pharmaceutical gelatin include various types of pectins. At present they are used in food and pharmaceutical industries. Pectins are capable of forming gel systems, 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.

Analysis of the world literature shows that as an alternative to produce gelatin capsules, various neutral and acidic plant polysaccharides may be used: modified and unmodified starches, gums and different kinds of carrageenans, pectins, cellulose derivatives—hydroxypropylmethylcellulose and carboxymethylcellulose [4]. It should be noted that the Russian Federation has both—sufficient acreage and production base to produce the majority of the above components. Moreover, the crisis in the livestock sector, linked with the spread of infectious diseases (swine flu, spongiform encephalitis of cattle) among productive animals, by-products, which are used as raw materials for producing gelatin, is an additional factor that contributes to the relevance of research on the composition of plant polysaccharides, which are an alternative to gelatin in the manufacture of capsules [5].

The aim of this study was to measure the ratio of the integral light transmission and thickness of capsule shells, derived from plant analogs of pharmaceutical gelatin.

Materials and Methods

Materials used in the study include the following:

– Corn starch (Danisco, Denmark);

– Glycerol (99.0%, AppliChem, Germany);

– Gelatin (AppliChem, Germany);

– Kappa-carrageenan (Danisco, Denmark);

– Iota-carrageenan (Danisco, Denmark);

– Gelamil 308 (Danisco, Denmark);

– Amylase starch (Danisco, Denmark).

The capsules investigated in this article were conditionally divided into three groups depending on the composition [6,7].

The samples obtained from plant analogs of pharmaceutical gelatin (in an amount of 10 pieces) were separated by visual characteristics into three groups and numbered.

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Samples from each group were examined.

Measurement of the integral light transmission was done with Cary 100 Scan UV-Visible Spectrophotometer with the prefix of diffusion reflection in the transmission mode for semi-transparent samples [8,9].

The thickness of the shells was measured with a specially designed testing machine [10,11].

Results and Discussion

As a result of measurement of the integral light transmission, the dependences shown in Figure 1 were obtained.

The numbering of transmission spectra corresponds to the numbering of the samples of capsule shells based on plant analogs of pharmaceutical gelatin (1-10).

The figure shows that the ratio of the integral light transmission is in the same range for all the studied samples of capsule shells. This indicates the light-transmitting capacity is approximately equal for all shell samples of plant analogs of pharmaceutical gelatin. However, the shell sample No. 10 is characterized by light transmittance at a longer wavelength of passing light. This sample was prepared without the addition of gelatin, indicating more light transmittance at a wavelength of transmitted light for pure analogs of pharmaceutical gelatin.

Light transmission coefficient is a parameter that does not depend on the concentration and thickness of the coating layer; it depends only on the composition of shell and the wavelength of the transmitted light.

When measuring the thickness of films removal schematic sample thickness points were observed.

The measurement results are shown in Table 1.

From the table of data, it follows that the maximum thickness is for the sample of capsule shell No. 2; its value is 1.378. It is completely composed of gelatin (with only the addition of glycerol as plasticizer and water). Sample No. 8 has the smallest thickness, with the value of 0.592. It consists of kappa-carrageenan, iota-carrageenan, and corn starch. The data obtained allow us to conclude that the shell of the plant analogs of gelatin obtained from *ceteris paribus* is quite thin, but durable, so you can use plant analogs of pharmaceutical gelatin for the production of soft capsules for medical purposes.

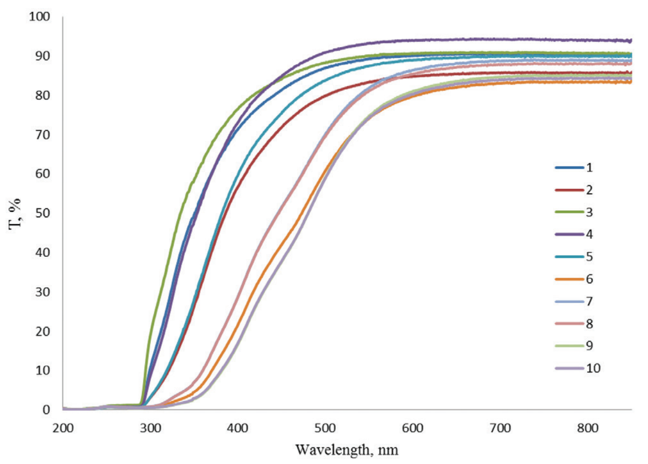

Figure 1: The dependence of the light transmittance of the wavelength

No.	Sample No.	Single measurements, mm	The average value, mm
1	6	0.72 0.73 0.67	0.703
2	7	0.62 0.66 0.67	0.698
3	8	0.56 0.56 0.57	0.592
4	9	0.89 0.86 0.89	0.888
5	10	0.87 0.86 0.86	0.876
6	1	1.1 0.7 0.7	0.912
7	2	1.18 1.32 1.48	1.378
8	3	0.84 0.78 0.79	0.812
9	4	1.15 1.15 1.15	1.104
10	5	1.22 1.21 1.02	1.022

Table 1: Results of the thickness measurement of the gelatin shell samples

Conclusion

Thus, it was found that the ratio of the integral light transmission lies in the same range for all the studied shell samples, indicating the approximately equal light-transmitting ability of the films of all the samples of gelatin and plant equivalents. It was also found that the sample derived from pharmaceutical gelatin has the maximum thickness, and the sample from plant analogs, such as corn starch and carrageenan, has lower thickness.

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