Study of rheological properties of carbomer gels

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Abstract: The first step of semisolid drugs development is a selection of appropriate base. As we plan to develop a preparation for treating of inflammatory periodontal diseases, it is necessary to take into account some requirements: base should provide a pH close to the pH of the mouth mucous membranes, be easily and painlessly applied to the gums, be uniformly distributed, have a light texture. **Results**: As the optimal basis should be easily applied to the oral mucosa, does not spread and possess medium fluidity, for further studies, we have chosen a carbomer with concentration of 1%. In order to study the strength of the carbomer gel structure as well as to determine the flow type and the thixotropic properties we constructed a rheogram of studied base, showing the dependence of the shear stress τ from velocity gradient Dr. In the investigation of dependence of the structural viscosity on the shear velocity gradient can be seen that the structural viscosity of the studied gel base gradually decreased with increasing shear rate gradient. A result of researchers found that the most active carbomer swelling process occurs between 25 to 30 minutes. The maximum viscosity observed during the swelling within 30 min. Then, over the entire range of the gel swelling time rheological characteristics are virtually unchanged. **Discussions**: Was determined the optimal concentration of studied gelling agent - carbomer - 1%. Was proved that the gel base with studied gelling agent has non-Newtonian flow type with plastic properties and possesses thixotropic properties. For gels with formed structure the optimal carbomer swelling time is 30 min.
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Keywords: Carbomer gel, thixotropic properties, rheogram, rheological characteristics.

1. Introduction

The first step of semisolid drugs development is a selection of appropriate base. As we plan to develop a preparation for treating of inflammatory periodontal diseases, it is necessary to take into account some requirements: base should provide a pH close to the pH of the mouth mucous membranes, be easily and painlessly applied to the gums, be uniformly distributed, have a light texture [1].

Based on the above mentioned requirements are optimal carbomers based gels [2]. It is known that when developing the gel is important not only select a gelling agent, but also its concentration. Mandatory step in creating of new effective semisolids is the study of the structural and mechanical properties of the base. Determination of the structural viscosity, thixotropy, swelling ratio of base, especially for gels, initially, allows to estimate the quality of the developed product [3].

The study of structural and mechanical properties of carbomer gels bases for the further development of dental products of semisolid dosage form.

2. Material and Methods

As objects of the study were selected gel bases with different concentrations of carbomer 971R. Structural and mechanical studies of gels experimental samples were performed using a Brookfield viscometer DV-II + PRO (USA) with the spindle RV7 and software «Brookfield Rheocalc 32".

Structural viscosity was determined as follows: gel sample (about 100.0 g) was placed in the chamber and it was lowered into the spindel, which was driven from low strain rates, fixing the structural viscosity readings on a computer monitor using the software «Brookfield Rheocalc 32" [4, 5].

The pH of the samples was determined by the potentiometric method on the appliance «HI 2210 pH Meter» (Germany).

3. Results

To study the physico - chemical and rheological properties prepared gels with different concentrations of the gelling agent (Fig. 1). Gels prepared by the following technologies: required quantity of gelling agent was poured by a part of purified water, kept at a temperature of 20-25^{0}C and allowed for swelling within 30 minutes, then added the rest of water and neutralizer triethanolamine. Than the gel was mixed in a special apparatus "Sito Ungvator 2000" (Germany) at 800 rev / min for 40 minutes. Were obtained colorless, transparent, odorless, non-adhesive gels with a pH of 5.0 - 5.3.

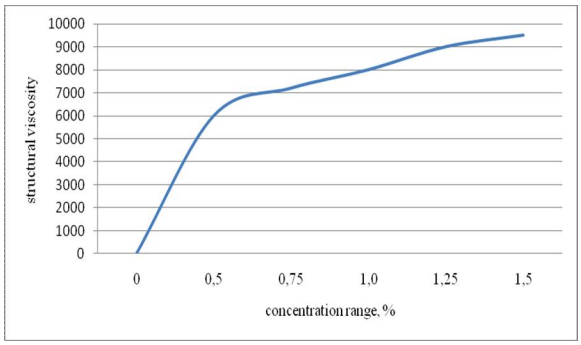

Figure 1 – Dependence of the experimental samples structural viscosity on the concentration of carbomer

As is evident from Fig. 1, the structural viscosity of samples sharply increases at increasing of carbomer concentration in the tested concentration range (0.5 to 1.5%). Samples with concentration up to 0.5% were liquid, and with concentration above 2% - very dense, with clots, which can then cause problems in the development of the drug and its administration so these samples were immediately eliminated.

As the optimal basis should be easily applied to the oral mucosa, does not spread and possess medium fluidity, for further studies, we have chosen a carbomer with concentration of 1%.

In order to study the strength of the carbomer gel structure as well as to determine the flow type and the thixotropic properties we constructed a rheogram of studied base, showing the dependence of the shear stress τ from velocity gradient Dr (Fig. 2).

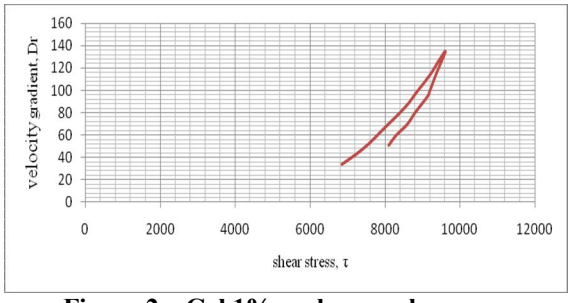

Figure 2 – Gel 1% carbomer rheogram

Data of rheological parameters were obtained by the continuous ever-increasing destruction of the structure as a function of shear stress. Determinations were carried out at increasing the spindle speed from 50 to 200 rev/min, reaching a constant shear stress at maximum speed and then at reduction the spindle speed [6].

As can be seen from Fig. 2 carbomer gel refers to non-Newtonian flow type and has plastic properties. Under the effect of high shear stresses, the gel structure was destroyed, and at lower shear viscosity of the gel structure was restored. "Rising" hysteresis loop curve shows reducing of structural viscosity because of the destruction of the gel structure, and the "downward" curve reflects a certain equilibrium state in which studied system has been after the destruction. Presence of the hysteresis loop shows that carbomer gel possesses thixotropic properties.

In the investigation of dependence of the structural viscosity on the shear velocity gradient can be seen that the structural viscosity of the studied gel base gradually decreased with increasing shear rate gradient (Fig. 3).

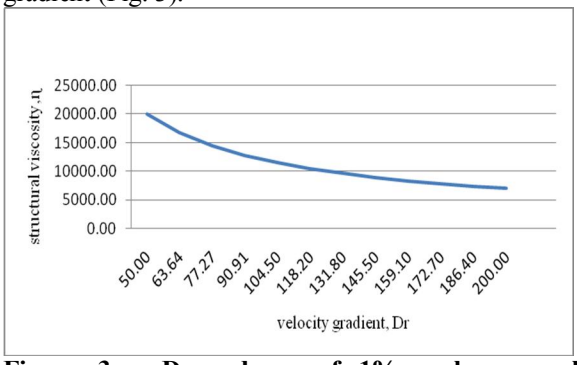

Figure 3 – Dependence of 1% carbomer gel structural viscosity on shear rate

This dependence is typical for systems with a plastic flow type and characterizes the studied gel base as a structured dispersion system. Consequently, the use of carbomer as a gelling agent in the development of dental formulation provides easier, painless and homogenous spreading of the gel on the gums.

It is known that polymer gelling is a kinetic process and may evolve during long time [6, 7, 8, 9, 10, 11, 12]. In this regard have been conducted studies of the swelling effect on carbomer solution viscosity. Results of the study are shown in Figure 4.

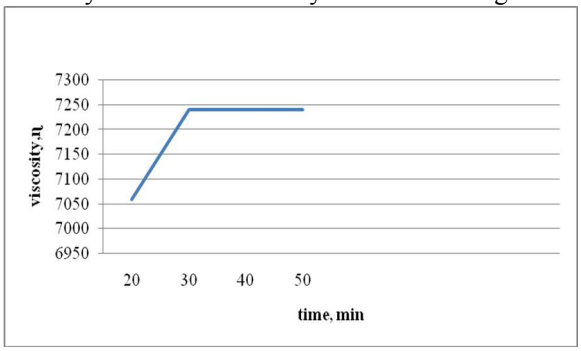

Figure 4 – Dependence of carbomer structural viscosity on gel swelling time

A result of researchers found that the most active carbomer swelling process occurs between 25 to 30 minutes. The maximum viscosity observed during the swelling within 30 min. Then, over the entire range of the gel swelling time rheological characteristics are virtually unchanged.

4. Discussions

Was determined the optimal concentration of studied gelling agent - carbomer - 1%. Was proved that the gel base with studied gelling agent has non-Newtonian flow type with plastic properties and possesses thixotropic properties. For gels with formed structure the optimal carbomer swelling time is 30 min.

Obtained data will be used in the development of dental drug in form of gel.

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References

1. Cozir, G.R., 2003. Developing a new drug dental gel with propolis. Pharmaceutical journal, 1: 78-82.
2. Bolshakova, L.S., E.V. Litvinova, N.D. Zhmurina and E.I. Burtseva, 2012. The influence of different technological factors on the rheological characteristics of alginats gels. Modern problems of science and education, 6: 31-33.
3. Baranova, I.I., 2009. Study of physical-chemical and structural-mechanical properties of hydrogel based on polymer composition «Salcare-80». Ukrainian journal of clinical and laboratory medicine. 4: 16-18.
4. Malkin, A.Y., 2007. Rheology: concepts, methods, and applications. Profession, UK: William Andrew, pp: 557.
5. Choeierova, Y., 2001. Application of simple rheological studies to compare the fluidity of cosmetic thickeners. SÖFW (Russian version), 2: 45-50.
6. Baranova, I.I., 2008. Comparative characteristic rheoparametris gels of different origin. Zaporozhye medical journal. 4: 81-84.
7. Slepnev, M.V., 2004. Development extemporal gels based on acrylic polymer Arespol. Abstracts of XI Russian national Congress. Man and medicine, pp: 836.
8. Sliusar O.I., 2003. Study the influence of various factors on the structural-mechanical and technological characteristics of the hydrogel fundamentals of polymer acrylic acid. Veterinary pathology, 4: 44 – 48.
9. Moldaver B.L., 2003. Comparative study of physico-chemical and technological properties of foreign and domestic acrylic polymers. Abstracts of X Russian national Congress. Man and medicine, pp: 636.
10. Resin Handing and Storage. The proven polymers in pharmaceuticals. Bulletin 5.B.F. Goodrich, 2002.
11. Datkhayev U., Shopabayeva A., Zhakipbekov K., Yermekbayeva D., Orazbekov E., Turgumbayeva A. Basic aspects of the organization of the pharmaceutical industry. Life Sci J 2013; 10(7s): 677-683. (ISSN:1097-8135). http://www.lifesciencesite.com. 106.
12. Botabayeva R., Shertaeva C., Blinova O., Datkhayev U., Shopabaeva A., Zhanabayev N., Zhakipbekov K. Methodical approaches to a strategy of diversification to advance domestic production of medicines. *Life Sci J* 2013;10(12s):302-309. (ISSN:1097-8135). http://www.lifesciencesite.com. 53.

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