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Research Of Rheological Properties Of Ointment With Water-Soluble Protein-Polysaccharide Complex Of Oyster Mushroom

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Abstract

The problem of the treatment of scar tissue of the skin is quite relevant. This is due to a large number of patients with this pathology, frequency and unpredictable manifestation of scarring, which greatly affects the quality of human life and causes a lot of inconveniences. Today, there are many methods and tools for treating and preventing scar tissue, but the most common use is the use of soft dosage forms.

Goal. A goal is an investigation of the structural and mechanical properties of emulsion ointment compositions with a water-soluble protein-polysaccharide complex (WSPPC) of Oyster mushroom and the establishment of an optimal concentration of emulsifier in their composition.

Methods. In the process of producing and storing soft dosage forms objective control of quality can be used for study their rheological performance. The objects of the study were ointment compositions on emulsion bases, the active substance of which was a water-soluble protein-polysaccharide complex of Oyster mushroom. The study of the structural and mechanical properties was carried out using a rotary viscometer «Rheolab QC» (Anton Paar, Austria).

Research results. Rheological properties characterize the consistency of soft dosage forms which affect the basic technological and consumer characteristics of the dosage form. Thus most ointments under the action of mechanical forces behave as elastic bodies characterized by reversible deformation.

Conclusions. The structural and mechanical properties of soft dosage forms depend on the concentration and nature of the emulsifier. During the study it was found that all ointment compositions are structured systems as well as the most optimal composition of the ointment, which provides the necessary thixotropic properties.

Keywords: soft dosage forms, ointment, rheological properties, Oyster mushroom, water-soluble protein-polysaccharide complex.

INTRODUCTION.

A search and a development of new drugs with anti-scarring activity are becoming increasingly urgent since scar formation is a widespread problem for people around the world. Scars can occur as a result of various skin injuries (burns, injuries, surgical operations, dermatological diseases, etc.) and cause discomfort, unpleasant feeling, depression and the decreased functionality of the skin. At this stage of modern medicine and pharmacy development there is a large number of methods for combating this pathology. But an analysis of literature data shows that a method of medical treatment by use of drugs of local action is the most widespread [1]. Proceeding from this the most affordable, convenient and comfortable way to treat scar formation is the use of soft dosage forms, so developing an effective ointment anti-scarring activity is an urgent task of pharmaceutical technology.

Soft dosage forms are complex systems characterized by the corresponding structural-mechanical (rheological) properties [2, 3]. The therapeutic value of ointments largely depends on the rational choice of ointment bases since the correct combination of its components affects not only the speed and completeness of release of active substances, but also provides the corresponding technological and consumer properties of the soft dosage forms (appearance, ability to smear and tubing extrusion, packing and storage stability, etc.) [2]. Thus a system of quality assurance of soft dosage forms involves a standardization of structural and mechanical parameters, which according to the concept of rheology includes plasticity, structural viscosity and thixotropy [2, 8, 9]. A definition of these indicators can serve as an objective control of quality of soft dosage forms in the process of manufacturing and storing [4].

MATERIALS AND METHODS OF RESEARCH.

The objects of the study were ointment compositions on emulsion bases, which were selected as the most promising in the course of determining the biopharmaceutical availability by means of dialysis through a semipermeable membrane [5]. Water-soluble protein-polysaccharide complex (WSPPC) of Oyster mushroom was an active ingredient of the developed dosage form. The compositions of ointment formulations are given in Table 1.

It is known that most ointments under the influence of mechanical forces behave as elastic bodies characterized by reversible deformation. At the same time when changing the conditions, including the deforming force, the gradient of the shear rate, the degree of homogenization and other variables, and the viscosity of the ointments changes in a wide range too. The study of rheological parameters of these systems helps to characterize these changes [8, 9].

A comparative study of the rheological characteristics of the ointment compositions with WSPPC on emulsion bases was carried out using a rotary viscometer "Rheolab QC" (Anton Paar, Austria) with a system of coaxial cylinders. For establish the consistency of the systems the sample of the ointment composition was placed in the capacity of the outer cylinder of the rotary viscometer. Using the thermostat, the required test temperature was set to 25ºC and the thermostat was set up for 30 minutes. Then, with the help of the software of the device the necessary conditions for the experiment were installed - the gradient of the rate of displacement of the inner cylinder (0.1 to 350 s^{-1}), the number of experimental points on the flow curve (115) and the duration of measurements at each point of the curve (1s).

Table 1 -Compositions of ointment formulations

Sample №	Composition	Quantitative content of constituents, g
6.	WSPPC Sunflower oil Distilled monoglycerides Twin 80 Emulsifier No. 1 Purified water	5,0 15,0 4,0 2,0 7,5 up to 100,0
8.	WSPPC Sunflower oil Distilled monoglycerides Emulsion wax Glycerol Emulsifier No. 1 Purified water	5,0 15,0 5,0 3,0 15,0 5,0 up to 100,0
9.	WSPPC Corn oil PEO-400 Propylene glycol Emulsifier No. 1 Purified water	5,0 20,0 10,0 10,0 8,0 up to 100,0

The study of thixotropic properties (restoration after complete destruction) was carried out in three stages:

- constant displacement at the speed of 1 s^{-1}, 5 measurement points, the measurement time of the point is 5 s;
- constant displacement at the speed of 150 s^{-1}, 50 measurement points, the measurement time of the point is 1 s;
- constant displacement at the speed of 1 s^{-1}, 250 measurement points, the duration of the measurement point 1 s.

RESULTS AND DISCUSSION.

Structural and mechanical characteristics reflect such a concept as "consistency" that significantly affects for a large number of technological processes of soft dosage forms (homogenization, pipeline transportation, packaging, etc.), as well as the main properties when used: tubes extrusion (extrusion ability), application to the skin or mucous membrane (uniform distribution, adhesive properties), which ultimately affects the effectiveness of the drug [4, 6, 7].

The results of experimental studies were processed using the software included in the equipment of the device and presented in the form of charts. Thus, flow rheograms and viscosity dependence on shear rate gradient, presented in Fig. 1, were constructed.

The obtained curves of the ointment compositions (flow rheograms) are non-linear in nature and are described by the ascending and descending curves, form a "hysteresis loop". The ascending curve shows the damage and stability of the system, while the descending one characterizes its restoration and is explained by the persistence of residual deformation after a strong weakening of the structure under the action of the applied voltage. The presence of a “hysteresis loop” indicates that the ointment compositions have thixotropic properties, the presence of which characterizes the ability of the ointment to spread, squeezing out of tubes and other technological and consumer properties [6].

Based on the results presented in Fig. 1, it can be concluded that the 9 sample is characterized by better thixotropic properties, since the 6 sample has a very dense texture, and the 8 one will not be sufficiently stable during the process and storage. Thus, the 9 sample has the best consistent properties; therefore the following studies were aimed at improving the structural and mechanical properties of the sample and studying the role of the emulsifier in the selected composition of the ointment composition. During the experiment, the amount of emulsifier in the selected composition was reduced and additional rheological studies of the compositions were carried out. The compositions of the investigated formulations are given in Table 2.

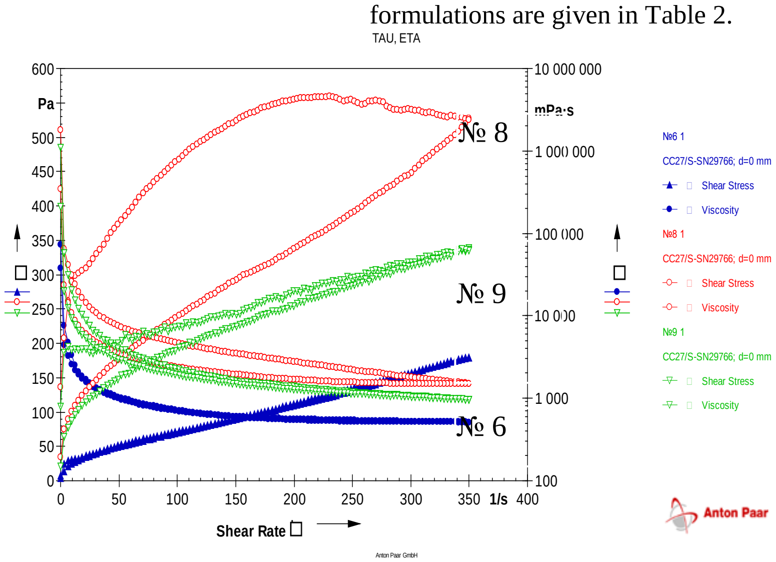

Figure 1 - Flow rheograms and the dependence of the structural viscosity on the shear rate gradient

Table 2 Compositions of the improved ointment formulations

Sample №	Composition	Quantitative content of constituents, g
9.	WSPPC Corn oil PEO-400 Propylene glycol Emulsifier № 1 Water is purified	5,0 20,0 10,0 10,0 8,0 up to 100,0
9.1	WSPPC Corn oil PEO-400 Propylene glycol Emulsifier № 1 Water is purified	5,0 20,0 10,0 10,0 7,0 up to 100,0
9.2	WSPPC Corn oil PEO-400 Propylene glycol Emulsifier № 1 Water is purified	5,0 20,0 10,0 10,0 6,0 up to 100,0

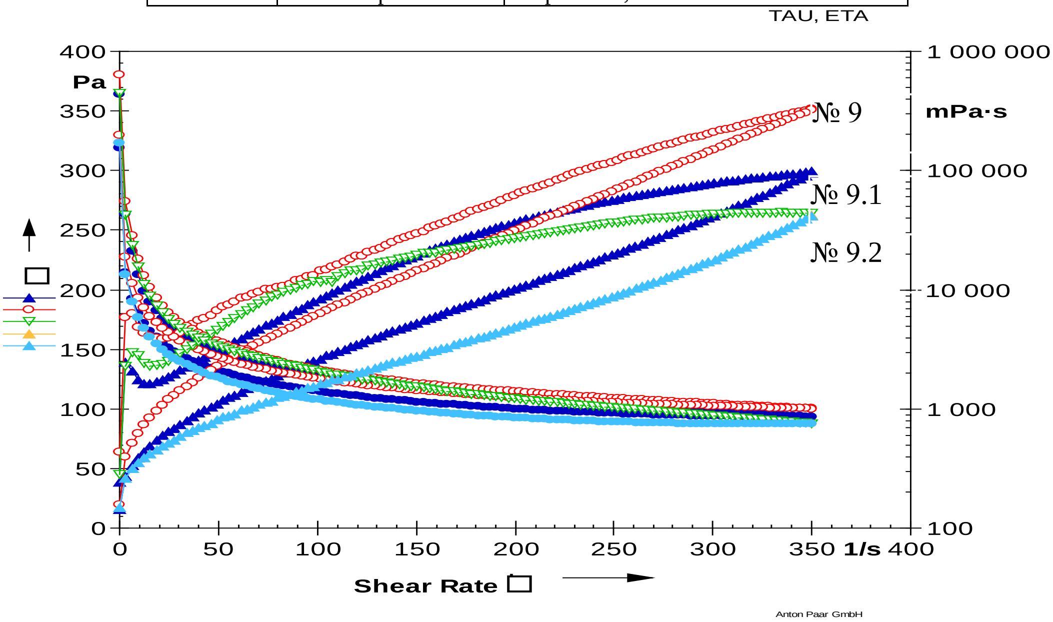

Figure 2 - Flow rheograms and the dependence of structural viscosity on the shear rate gradient

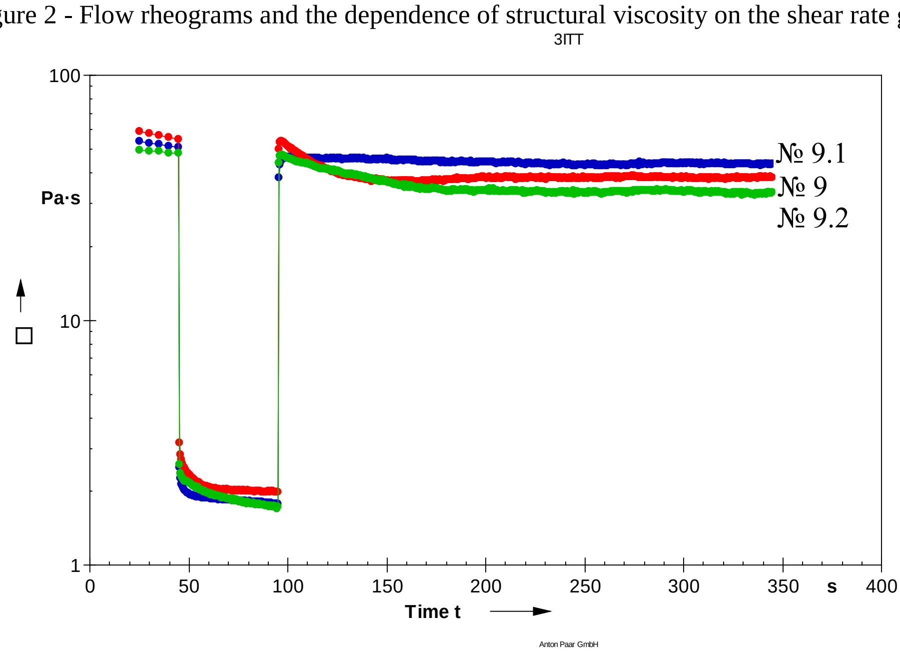

Figure 3 - Restoring the structure of ointment samples after the complete destruction of the structure

The results of rheological studies of selected compositions are shown in Fig.2.

Thus, the determination of the dependence of the structural viscosity on the shear rate gradient for emulsion ointments showed that the viscosity of the compositions decreases with increasing shear rate gradient. This dependence suggests that the systems under study have a certain structure.

The obtained flow curves of the systems under study indicate that their destruction does not begin immediately, but only after the application of the voltage necessary to break the structure elements. The section of the rheogram with a straight line corresponds to the destruction of the structure, during the period of weakening the voltage is gradually restored, albeit with a delay. This phenomenon confirms the plastically dense properties of ointments [6, 7].

The next stage of the study of the structural and mechanical properties of selected ointments was to conduct a test to restore the structure after complete destruction. The results are presented in Fig. 3.

The results obtained make it possible to conclude that all samples slowly and gradually restore their structure. However, the samples № 9 and 9.2 are the most technologically advanced, because, after a decrease in voltage, they are characterized by a high-density value, which falls during recovery. It can be said that according to the rheological characteristics, it is these ointments that are characterized by the corresponding technological and consumer parameters.

CONCLUSIONS.

1. The study of the structural-mechanical properties of the developed ointment compositions showed that these are the structured systems with pronounced thixotropic properties.

2. The 9 and 9.2 samples were chosen as the most promising because it is such a combination of excipients with WSPPC that provides the necessary thixotropic characteristics and restoration of the structure that provides the necessary technological and consumer properties of the selected composition.

Thus, the selected ointment compositions have the corresponding structural and mechanical characteristics and can be used in further studies to develop a soft dosage form of anti-scarring action.

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