ORIGINAL ARTICLE

The Influence of Propellant on the Technological Qualities of a Floating Aerosol

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Abstract

Introduction: The aim of the research was to substantiate the amount of propellant in the composition of the aerosol concentrate, depending on the consumption characteristics of the film formed on the wound surface. The publication experimentally substantiates the concentration of propellant chladon-134a, which is a necessary component for the formation of a film-forming aerosol. **Materials and Methods:** The authors used modern research methods: Pharmacotechnological and physicochemical – to substantiate the optimal amount of propellant in the composition of the developed aerosol film forming. **Results:** Studies have shown that the type and amount of propellant affects the film formation. The authors found that depending on the amount of propellant in the balloon, the type of delivery of the solution from the balloon will change – or sprayed, or removed smoothly; the appearance of the film depends on the amount of propellant – smooth, shiny, as well as the percentage of concentrate dispensing from the aerosol container. **Discussion and Conclusion:** Physicochemical studies have proved the influence of propellant on the technological parameters of the film-forming aerosol: Type of delivery, appearance – colorless film with a smooth shiny surface; film thickness – 10–200 μ; drying time – 10–15 min; and the percentage yield of the contents of the aerosol container – 97.84 ± 2.31%. The use of propellant chladon 134a at a concentration of 10% was found to be optimal. At this concentration, the highest percentage yield of the contents of the aerosol container is ensured, which allows to obtain a film with a smooth type of delivery and satisfactory consumer characteristics.

Key words: Aerosol, chladon, consumer characteristics, propellant, technology

INTRODUCTION

Local treatment of wounds remains one of the urgent problems of modern medicine. It is proved that irrespective of the genesis and localization of wounds,[1] their healing proceeds according to the same biological mechanism during three phases of the wound process that consistently passes into each other. The effectiveness of local drug therapy in the use of various drugs depends on the differentiated use of drugs depending on the phase of the wound process.[2]

Practical medicine has a number of drugs for external use in the treatment of various wounds. However, they do not fully meet the current requirements of clinicians,[3] because in most cases, they do not take into account the peculiarities of drug therapy of different phases of the wound process and have insufficient effectiveness. Improving the effectiveness of drugs for topical treatment of purulent wounds is possible through the development of new combination drugs intended for use in a particular phase of the wound process.[2,3]

Important features of aerosol packaging are the generation of particles of optimum size and a sufficiently high kinematic rate of release of the contents of the balloon, which

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contributed to the introduction of aerosol dosage forms in medical practice.[4]

The dominant direction of the development of the technology of drugs in the XXI century was the modification of the component composition, as well as indicators of the rate of release and directionality of biologically active substances.[4,5] The parameters of the most important technological operations, such as emulsification, foaming, film forming, and stabilization, are studied. Furthermore, studies of major classes of excipients, in particular surfactants, propellants, solvents, pharmacological features, and mechanisms of action of drugs in the form of an aerosol, were conducted, which eventually allowed to develop the technology of drugs of different directions in the form of pharmaceutical aerosols.[5]

The analysis of the historical stages of the development of the main types of dosage forms intended for topical impact on the wound process, confirms the relevance of the inclusion in the therapeutic process of dermatological nosologies of drugs in the form of aerosols, which are tailored to the specificity of the wound process and capable of influencing the main pathogens of these pathogens. Diseases based on the relevance, we have developed the composition and technology of film-forming aerosol antimicrobial and anesthetic action for the treatment of wound process.[1,3,4]

The aim of the research was to substantiate the amount of propellant in the composition of the aerosol concentrate, depending on the consumption characteristics of the film formed on the wound surface.

MATERIALS AND METHODS

In the course of the experimental research, the authors used active pharmaceutical ingredients – ofloxacin, miramistin (gift sample from Dr. Reddy's labs, Hyderabad, India), anesthesia (Merck, Germany), and adjuvants – sodium carboxymethyl cellulose, methyl cellulose propylene glycol, eudragit NM30D, glycerine (Loba Chemie Pvt. Ltd., Mumbai, India), polyethylene oxide-400, polyethylene oxide-1500, polyvinylpyrrolidone, polyvinyl alcohol, sodium cetearyl sulfate, citric acid monohydrate, ethanol, and chladone-134a (Sigma-Aldrich, Germany). All the chemicals, emulsifiers, and reagents were of analytical grade.

The appearance and the characteristic organoleptic properties of the aerosol concentrate (color, odor, and consistency) as well as signs of physical instability (particle aggregation, coalescence, coagulation, and delamination) were controlled. The studies were performed according to the requirements of the State Pharmacopoeia of Ukraine.[6]

Determination of the percent yield of balloon content was performed according to the State Pharmacopoeia of Ukraine. The tests were performed on at least three cylinders from each series. The yield must be at least 90% by weight of the contents of the container indicated on the label.

Valve and nozzle check. The tests were performed at least three cylinders from each series. The valve should open when the finger on the nozzle mounted on the valve is pressed and immediately closed after closing the valve. The contents of the balloon should only come out through the opening of the nozzle and the valve should seal the balloon inoperative.

The type of delivery of the film-forming solution from the aerosol container was checked visually. When dispensing from the balloon, the solution may be sprayed, dispensed smoothly or intermittently. The solution may have a quiet or noisy delivery. In appearance, they are with a smooth, shiny or matt surface, wrinkled, bubbly, etc.

The research was conducted in five series (five samples in each). Statistical analysis of the obtained results was made using Statistica 6.0 (StatSoft Inc., USA). Data in the tables were provided as $x \pm SE$, where x is average value of the indicator and SE is standard deviation. The results were considered statistically reliable at $P < 0.05$.[7-10]

RESULTS

In the first phase of research, we substantiated the concentration of propellant, which is a necessary component for the formation of a suitable drug.

The research used the propellant chladon-134a. From our own research, it is known that depending on the amount of propellant in the balloon, the type of delivery of the solution from the balloon will change – or sprayed, or removed smoothly. In addition, the appearance of the film depends on the amount of propellant – smooth, shiny, as well as the percentage of concentrate release from the aerosol balloon.

The 30 ml aerosol cans were placed in a pre-made concentrate of 20 g, sealed with continuous action valves, and added chladone-134a (chladon 11:12 [50:50]), the amount of which was from 5% (1.25 g) to 35% (8.75 g) per aerosol balloon. The step of increasing the concentration was 5%.

The criterion for selecting the optimal amount of propellant was the study of its effect on the technological performance of the film-forming aerosol: Type of dispensing, appearance, thickness, drying time, and the percentage of delivery of content from the balloon. The results are shown in Tables 1 and 2.

Based on the research, it can be argued that the type and amount of propellant affects the film formation. By the type of dispensing and the appearance of the film formed with samples containing 10% of halon-134a content, the film is presented colorless with a smooth shiny surface and

Table 1: Consumption characteristics of the film depending on the concentration of propellant (chladon-134a),x±SE

Propellant content,% in balloon/ concentration (g) of propellant	Characteristics of the film				
	Type of issue	Appearance films	Thickness, mcm	Drying time, min	Output %
5.0/1.25	Abrupt	Colorless film with a matt surface	10–50	5–7	90.11±2.37*
10.0/2.5	Smooth	Colorless film with a smooth shiny surface	100–200	10–15	97.84±2.31*
15.0/3.75	Smooth	Colorless film with a smooth shiny surface	100–200	8–12	93.24±3.12*
20.0/5.0	Noisy, break frequent	Colorless film with a smooth shiny surface	10–100	5–7	86.36±2.44*
25.0/6.25	Noisy, break frequent	Colorless film with a smooth shiny surface	10–100	8–12	78.31±2.74*
30.0/6.25	Noisy, break frequent	Colorless film with a smooth shiny surface	10–100	8–12	72.33±1.78*

*P<0.05 in accordance with the Newman-Keyles criterion

Table 2: Consumption characteristics of foam depending on the concentration of propellant (chladone 11:12 [50:50]),x±SE

Propellant content, % in balloon/concentration (g) of propellant	Characteristics of the film				
	Type of issue	Appearance films	Thickness, mcm	Drying time, min	Output %
5.0/1.25	Abrupt	Colorless film with a matt surface	<10	5-7	22.11±1.34*
10.0/2.5	Abrupt	Colorless film with a matt surface	10–50	5–7	74.83±1.21*
15.0/3.75	Abrupt	Colorless film with a matt surface	10–50	10–12	85.13±1.45*
20.0/5.0	Noisy, break frequent	Colorless film with uneven surface	10–100	10–15	88.02±1.43*
25.0/6.25	Noisy, break frequent	Colorless film with a smooth surface	100–150	10–15	93.83±1.35*
30.0/6.25	Smooth	Colorless film with a smooth shiny surface	100–200	10–15	98.04±1.27*

*P<0.05 in accordance with the Newman-Keyles criterion

a smooth type of dispensing. Films formed with specimens containing halon 11:12 (50:50) form a film of similar quality at a propellant concentration of 30%. It is established that the increase of the propellant concentration from 5% to 15% increases the thickness of the film, which, in our opinion, is related to the type of aerosol release, the increase in the percentage of the gaseous phase, and the decrease in the density of the solution. However, as the thickness of the film increases, the drying time of the film also increases. The latter, in turn, is related to the indicator "percentage output of the contents of the aerosol balloon."

It is proved that increasing the amount of propellant from 15% to 30% [Table 1] leads to a decrease in the percentage of the content of the contents of the balloon to 72.33±1.78. Further increase of chladone 134a leads to a gradual decrease of this indicator.

An increase in the concentration of halon 11:12 (50:50) from 5% to 30% leads to an increase in the percentage of delivery of contents from the balloon – 98.04±1.27 [Table 2].

DISCUSSION AND CONCLUSION

In the world of practice, a large number of pressurized pharmaceuticals are known. In the container of the film-forming drug is usually a solution of polymer, drug substance, plasticizer, and propellant, the spray of which on the surface of the skin or tissue forms a film that is tight and dries quickly. Substances used as film-forming agents should not irritate the skin and be toxic. The formed film should be impermeable to microorganisms, elastic, durable; with a high degree of adhesion, expressed bacteriostatic properties; without a harsh or unpleasant odor.

Thus, a comparative analysis of the data in Tables 1 and 2 found that the use of propellant chladon 134a at a concentration of 10% is optimal; film thickness of 10–200 μ; the drying time of the film is 10–15 min; and the percentage yield of the contents of the aerosol container – 97.84±2.31%.

REFERENCES

1. Chadayev A, Klimiashvili A. Modern methods of local drug treatment of injected wounds. Surgery 2013;1:43-56.
2. Kuzmin Y, Samson A, Samson M. Antibacterial therapy for purulent wounds. Emerg Med 2018;7:13-8.
3. Abrantes C, Duarte D, Reis C. An overview of pharmaceutical excipients: Safe or not safe. J Pharm Sci 2016;105:2019-26.
4. Davtian L, Vlasenko I. Microbial screening-the basis for the creation of drugs for the treatment of tropic ulcers. Retsept Int Sci Pract J 2017;20:69-78.
5. Davtian L, Voronkia A. The study of properties of the matrix for periodontal films based on metronidazole, chlorhexidine and glucosamine. Int J PharmTech Res 2016;9:9-12.
6. The State Pharmacopeia of Ukraine. State Enterprise Ukranian Scientific Expert Pharmacopoeial Center of the quality of Medicines. 2nd ed., Vol. 3. Kharkiv: The State Pharmacopeia of Ukraine; 2015. p. 1128.
7. Mincer O, Voronenko Y, Vlasov V. Treatment of Clinical and Experimental Data in Medicine. Kyiv: Vishha Shkola; 2013. p. 45-78.
8. Chan B, Li AS, Simpson J, Sternhagen G, Darvish O, Naisheng J, *et al*. Polypeptid polymers: Synthesis, characterization, and properties. Biopolymers 2017;3:34-48.
9. Davtian L, Maletska Z, Reva D. Technological aspects of dental medical films with chlorhexidine and decamethoxine. Int J Pharm Technol 2015;7:8166-73.
10. Davtian L, Drozdov O, Gladishev V, Pukhalska I. Pharmaceutical technology of extemporaneous medicines. Pharm J 2018;1:21-105.

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