1. Introduction

Helminthiasis of the digestive system is a socially significant problem that is relevant to many countries in the world. Active migration of the population, including for tourism purposes, contributes to the spread of atypical pathogens of this group of diseases.

In Europe, it is believed that one in three people have helmintic disease. The incidence of helminthiasis increases significantly in the autumn months (this is related to the life cycle of most pathogens and the return of children to children's collectives) [1].

In Ukraine parasitic diseases, including helminthiasis of the digestive system, are recognized as a nationwide problem due to the high level of their spread (the incidence of helminthiasis is equal to the incidence of SARS and ARI combined) and the degree of economic losses in their treatment [2]. In our country, the most recorded cases are related to enterobiasis, ascarisiasis and trichocephalosis: respectively, 458.5:138.01:21.4 cases per 100 thousand people. According to random studies, the prevalence of children with parasitosis is: 8.5 % of children who attend preschools; 11 % of students; 20 % of boarding school children with part-time and 100 % with full-time stay; 6.9 % of preschool children (up to 7 years old) [3].

For the most part, the symptoms of helminthiasis are so non-specific and varied that often the affected are not even aware of their condition. In 75.3 % of cases, helminthiasis is accompanied by disorders of the gastrointestinal system: pain in the right hypochondrium, nausea, impaired appetite, dyspeptic phenomena, decreased acidity of gastric juice, etc. [4].

The existing range of anthelmintic drugs in Ukraine does not fully meet the needs of the population. Thus, as of February 5, 2020, there are no drugs of the group P02B (drugs used for trematodoses) in the State Register of Medicinal Products, which complicates the treatment of some groups of helminthiasis of the digestive system, in particular, intestinal cestodes [5].

In view of the above, the development of the newest domestic drugs for the treatment of helminthiasis is an urgent task of pharmacy. We offered a drug containing albendazole and praziquantel in the ratio (1:4) as active ingredients in the dosage form tablets under the conditional name “AP-helmin” [6, 7].
The aim of the research. The aim of this work was to substantiate the technology of production of tablets “AP-helmin” and to establish the possible critical parameters, in accordance with the requirements of the Guidelines 42-3.1:2004 “Guidelines for quality. Medicines. Pharmaceutical Development”.

2. Planning (methodology) of the research
To meet the said purpose, we have identified the following tasks of the study:
- to study the physicochemical properties of a mixture of active pharmaceutical ingredients;
- to establish the need for the introduction of an additional technological stage of wet granulation;
- to investigate the properties of tablet mass of different composition and to choose the most rational for further development of the tablet-core;
- to reason the rational technology of obtaining tablets-cores of the selected composition and method of coating them;
- to develop the technological scheme of production of “AP-helmin” tablets, to establish the critical parameters of production and to forecast the possible types of quality control at different stages of production.

3. Materials and methods
The objects of the study were a mixture of substances albendazole and praziquantel (1:4), tablet mass and tablet core samples based on them.

Pharmacotechnological parameters of the mixture of substances, tablet mass and obtained samples of tablet cores were studied in the development and justification of the production technology of “AP-helmin” tablets. The studies were carried out in accordance with the requirements of the State Pharmacopoeia of Ukraine (SPhU) by conventional methods [8].

4. Results of the research
The first step in the development of “AP-helmin” tablet technology was to study the technological parameters of the mixture of substances albendazole and praziquantel (1:4)(Table 1).

As can be seen from the results in Table 1, the mixture of active substances albendazole and praziquantel in the ratio (1:4) has poor flowability (according to the flowability scale of SPhU 2.1, Table 2.9.36.-2), indicating the need to introduce the stage of granulation in the development of technology tablets with these substances.

The methods of dry and wet granulation were investigated. During dry granulation, a strong dispersion of the mass and its sticking to the technological parts of the equipment were observed, while using the wet granulation method, the resulting mass had satisfactory technological characteristics.

The wet granulation step was carried out with the addition of such excipients as corn starch, microcrystalline cellulose 101 (MCC-101) and povidone (as a 10 % solution).

The choice of excipients was carried out on the basis of well-known data on the technology of tablets, and also the economic affordability of these substances was taken into account.

Corn starch acts as a filler and loosening agent, giving the tablet mass of the necessary physical and chemical properties.

MCC-101 is used in the composition of tablet masses for wet granulation and in the amount of 5–20 % contributes to the rapid adsorption and uniform distribution of moisture, improving the efficiency of drying the tablet mass and improve the mechanical characteristics of the finished tablets [9, 10].

As a binder and wetting agent, povidone was used in the form of a 10 % solution at a standard concentration in the tablet mass of not more than 5 %.

Granulation was performed by wetting the tablet mass with 10 % solution of povidone, the formation of granules, drying the granules at a temperature of 50.0±2.0 °C for 2 h.

The obtained granules were dusted with magnesium stearate, which acts as an antifriction agent, in the amount of 1 %.

The composition of the samples of tablets-cores obtained by the above technology are given in Table 2.
According to the results of the studies in Table 2, the tablet mass of sample 1 is not sufficiently moist, that is, the formation of the granules will be impossible. Tablets-cores of tablet masses 2 and 3 have chips and cracks, which indicates their poor quality. The tablets-cores of sample 4 were homogeneous, which is why we conducted further studies with them.

The results of pharmaco-technological studies of tablets-cores of sample 4 are given in Table 3. Studies were conducted in five series of sample tablets.

| Indicator (SPhU method)                      | Value                                | Requirements of SPhU |
|----------------------------------------------|--------------------------------------|----------------------|
| Appearance (SPhU 2.0, pp. 1121-1125)         | Tablets oblong white, homogeneous, without chips and cracks | Responds             |
| Physical parameters                          | Length 19 mm (oblong)                |                      |
|                                               | Width 8 mm                            |                      |
|                                               | Height 6 mm                           |                      |
|                                               | Rib height 3 mm                       |                      |
| Average mass, g                              | 0.80±0.0032                          | –                    |
| Uniformity of mass, % (SPhU 2.0, 2.9.5)     | ±4.1                                 | Responds             |
| Resistance to crushing, N (SPhU 2.0, 2.9.8) | 96±0.02                              | Responds             |
| Disintegration (SPhU 2.0, 2.9.1), average    | 8 min 27±18 sec                       | Responds             |
| Friability (SPhU 2.0, 2.9.7), %             | 0.7±0.03                             | Responds             |

As can be seen from the results of the studies in Table 3, model sample 4 is a white core tablet, homogeneous, free from chips and cracks, and with a resistance to crushing and disintegration time, meet the requirements of SPhU (96 N and 8 min 27 sec, respectively).

The technology of production of tablets of the selected composition was developed taking into account the physicochemical and pharmaceutotechnological properties of active pharmaceutical ingredients. Critical stages and critical parameters of production, as well as predicted methods of control in the production process, were determined during the development of stages of the technological process [11, 12].

In order to ensure proper consumer characteristics (including the correction of the bitter taste of active substances and facilitating swallowing of the tablet due to smoothing of the roughness of the tablet and the sliding effect) and protect selected active pharmaceutical ingredients from environmental influences, a white coat Opadry II ®YS-1-7027 White (“Colorcon”) was introduced. The indicated coating was used in the form of a 2 % suspension applied to the surface of the core tablets (with the use of laboratory equipment Unilab-05-TJ BWI Huttlin GmbH).

Based on the researches, the technological scheme of production of “AP-helmin” tablets was developed (Fig. 1).

We identified the critical parameters of each stage of the manufacturing process of tablets, which can affect the quality of the finished product, reproducibility of production technology, including various series, and functional characteristics.

The obtained series of tablets according to the proposed technology is stored for the purpose of determining the shelf life of the drug.
5. Discussion
The results show that the physicochemical properties of the selected active pharmaceutical ingredients do not provide the proper flow characteristics. Therefore, it is advisable to introduce into the process the stage of wet granulation. It is advisable to carry out the stage of wet granulation with the addition of such excipients as corn starch, MCC-101 and povidone (in the form of a 10% solution). The number of selected excipients is experimentally justified. Physical parameters, average mass, uniformity of mass, resistance to crushing and disintegration time...
were determined for the tablets-cores of the selected composition.

To ensure the proper consumer characteristics of “AP-helmin” tablets, a coating step with the Opadry II @YS-1-7027 White (“Colorcon”) white film coat was introduced.

Thus, the technological scheme for the production of “AP-helmin” tablets has 9 main stages.

**Study limitations.** The studies conducted are based on the development of tablet technology in the laboratory conditions and do not fully reflect the possible risks of manufacturing this dosage form under industrial conditions. The critical parameters of quality control in the manufacturing process are described as predicted and require confirmatory research.

**The prospects for the further research.** The article describes the reasoning of the production of “AP-helmin” tablets and identifies the critical stages of the production process and the possible critical control parameters in the production process. The next stage of research is the testing of technology in the conditions of small-scale production, clarification of critical parameters of the production process and quality control, adaptation of technology to the conditions of industrial production.

**6. Conclusions**

The production technology of “AP-helmin” tablets based on the mixture of substances albendazole and praziquantel in the ratio (1:4) is substantiated and the rational introduction of the technological stage of wet granulation of the tablet mass is proved.

The technological scheme of production of “AP-helmin” tablets was presented. Critical parameters of technological process and quality control in the production process are determined.

**Conflict of interests**

Authors declare no conflict of interest.

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