Development of the spectrophotometric method for the quantitative determination of phenolic compounds calculated with reference to 6-gingerol in tablets based on a dry ginger extract

Zingiber officinale has a wide range of pharmacological properties, including hypoglycemic and antioxidant ones. Most literature sources associate the pharmacological activity and mechanism of action of ginger with the content of phenolic compounds, and in particular gingerol.

**Aim.** To develop the spectrophotometric method for the quantitative determination of the total amount of phenolic compounds calculated with reference to 6-gingerol in tablets based on a dry ginger extract.

**Materials and methods.** The study object were tablets with an average weight of 0.5 g containing 0.3 g of a dry ginger extract (manufacturer – “Medagroprom”, Dnipro) obtained by the direct compression method. The spectrophotometric method was used to determine phenolic compounds calculated with reference to 6-gingerol.

**Results and discussion.** The spectral characteristics of a standard sample of 6-gingerol, a predominant substance among biologically active phenolic compounds of ginger, have been studied. It has been shown that its absorption spectrum in the range from 220 to 400 nm contains one absorption band with a maximum at 281 nm, which can be used as an analytical absorption band for the quantitative determination by absorption spectrophotometry. It has been proven that excipients do not interfere with the quantitative determination of the total amount of phenolic compounds in the composition of tablets with a dry extract of ginger since they do not absorb electromagnetic radiation in the region of the analytical maximum. It has been found that the content of the total amount of phenolic compounds calculated with reference to 6-gingerol in the experimental batch of tablets is 0.03556 ± 0.0088 g/tab. The relative uncertainty of the mean determination was 1.007 %.

**Conclusions.** The spectrophotometric method for the quantitative determination of the total amount of phenolic compounds calculated with reference to 6-gingerol in tablets based on a dry ginger extract with the subsequent calculation by the standard method has been developed. It can be used to develop quality control procedures for the tablets under research.

**Key words:** spectrophotometer; dry extract; ginger; tablets; gingerol; diabetes mellitus
Introduction. Ginger (Zingiber officinale Roscoe) is a perennial herbaceous plant of the Zingiberaceae family. It is cultivated in many tropical and subtropical countries, including Australia, Nigeria and Haiti; moreover, China and India are the world’s leading producers of ginger.

In folk medicine, ginger is used to treat colds, rheumatism, angina, and digestive disorders, such as dyspepsia, nausea, vomiting, gastritis, and diarrhea. Lately, ginger has attracted attention because of its wide range of pharmacological activities, such as antitumor, antioxidant, anti-inflammatory, anti-diabetic, cytotoxic, anti-platelet ones [1].

The main bioactive components of ginger are essential oils, as well as phenolic compounds, such as gingerol and shogaol, which are responsible for the particular pungent taste of the plant. The preliminary pharmacological studies have made it possible to associate the hypoglycemic and antioxidant activity of a dry ginger extract with the 6-gingerol content [2, 3]. This confirms the relevance and prospects of its use for the development of hypoglycemic drugs [4].

To determine the total amount of phenolic compounds, which 6-gingerol belongs to, in herbal medicines, the spectrophotometric analysis is widely used [5].

Therefore, the aim of this work was to develop the spectrophotometric method for the quantitative determination of the total amount of phenolic compounds calculated with reference to 6-gingerol in tablets based on a dry ginger extract.

Materials and methods. The study objects were tablets with an average weight of 0.5 g, containing 0.3 g of a dry extract of ginger (manufacturer — “Medagroprom”, Dnipro). They were obtained by the direct compression method [6].

The solution of 6-gingerol by HPLC (manufactured by Akitin chemicals, Inc., China) was used as the standard solution.

On the basis of the previous studies of a dry ginger extract the optimal solvent – 40 % ethyl alcohol – was selected; it allowed the maximum extraction of pharmacologically active amount of phenolic compounds from the dry extract composition [7].

To quantify the total amount phenolic compounds calculated with reference to 6-gingerol in tablets the test solution, placebo solution and comparison solution were prepared.

Test solution and placebo solution. Place approximately 0.15 g of the powdered tablets or 0.06 g of the powdered mixture of excipients (accurate weight) in a 50 ml volumetric flask and add 30 ml of 40 % ethanol. After heating on a water bath, stirring and subsequent cooling dilute the solution to the volume with the same solvent. Filter the resulting solutions through a “blue ribbon” paper filter removing the first 5 ml of the filtrates. Place 5 ml of the solutions’ filtrates in 25 ml flasks and dilute to the volume with ethanol 40 % while stirring.

Comparison solution. Place 100 mg of the standard sample of 6-gingerol in a 50 ml volumetric flask, dilute the solution to the volume with 96 % ethanol and mix. After that place 1 ml of the initial solution of gingerol in a 50 ml volumetric flask, dilute to the volume with 40% ethanol and mix.
For the solutions obtained on an Evolution 60-S spectrophotometer the absorption spectra (Fig.) were taken in the range of 220-400 nm, and the optical density was determined at a wavelength of 281 nm in cells with a layer thickness of 10 mm. As the control solution 40 % ethanol was used.

Results and discussion. As can be seen in Fig., the absorption maxima of the standard 6-gingerol solution and the test solution of tablets with a dry ginger extract completely coincide in the absorption spectra of the solutions analyzed in the range from 220 to 400 nm. They contain one absorption band in the region where the aromatic compounds usually absorb with a maximum at 281 nm. The absorption band of the tablet mass solution is much wider, indicating the presence of the total amount of phenolic compounds with the similar structure. The coincidence of maxima indicates the possibility of their total quantitative determination with conditional calculation to 6-gingerol. The placebo solution does not absorb ultraviolet radiation in the region specified and thus cannot affect the results of the spectrophotometric quantitative determination of the total amount of biologically active compounds.

According to the results of determining the optical density of the test solutions and comparison solutions, the content of phenolic compounds in one tablet (in grams) calculated with reference to 6-gingerol was found by the formula:

$$X_{gt} = \frac{A \times V_1 \times V_3 \times m_{st} \times m_t}{A_{st} \times V_1^{st} \times V_2^{st} \times V_3^{st}}$$

where: $A_{st}$ – is the optical density of the standard solution; $A$ – is the optical density of the test solution; $V_1$ – is the volume of the first volumetric flask for preparation of the test solution; $V_1^{st}$ – is the volume of the first measuring flask for preparation of the standard solution; $V_2$ – is the volume of the aliquot when preparing the test solution; $V_2^{st}$ – is the volume of the aliquot when preparing the standard solution; $V_3$ – is the volume of the second dilution of the test solution; $V_3^{st}$ – is the volume of the second dilution of the standard solution; $m_t$ – is the sample weight of powdered tablets; $m_{st}$ – is the weight of the standard 6-gingerol sample; $m_i$ – is the average weight of a tablet.

The results are shown in Tab. 1.

**Table 1**

| No | Weight of the sample, g | Optical density, A | The content of the total amount of phenolic compounds calculated with reference to 6-gingerol, g/tablet |
|----|------------------------|-------------------|----------------------------------------------------------------|
| 1  | 0.1449                 | 0.417             | 0.03556                                                         |
| 2  | 0.1462                 | 0.430             | 0.03637                                                         |
| 3  | 0.1508                 | 0.421             | 0.03448                                                         |
| 4  | 0.1496                 | 0.427             | 0.03524                                                         |
| 5  | 0.1519                 | 0.451             | 0.03669                                                         |
| 6  | 0.1511                 | 0.429             | 0.03502                                                         |

Notes: $A_{st} = 0.398$; $m_t = 0.4914$ g.
Metrological characteristics of the analysis results

| The total amount of phenolic compounds found, g/g | $X_{av}$ g | $S^2$ | $S$ | $P$, % | $t$ (p,f) | $\Delta X_{av}$ | $\bar{e}_{av}$ % |
|------------------------------------------------|-----------|------|-----|------|---------|---------------|----------------|
| 0.03556                                         | 0.03556   | 6.98 x 10^{-2} | 0.000836 | 95 | 2.57 | 0.000877 | 1.007 |
| 0.03637                                         |           |      |     |      |         |               |                |
| 0.03448                                         |           |      |     |      |         |               |                |
| 0.03524                                         |           |      |     |      |         |               |                |
| 0.03669                                         |           |      |     |      |         |               |                |
| 0.03502                                         |           |      |     |      |         |               |                |

Notes: $S^2$ – dispersion; $S$ – standard deviation (separate determination); $P$ – reliability; $t$ (p,f) – Student’s criterion; $\Delta X_{av}$ – confidence interval of the mean determination; $\bar{e}$ – relative uncertainty of the mean determination, %.

The data obtained were subjected to statistical processing. The results are presented in Tab. 2.

Conclusions and prospects of further research

1. The spectral characteristics of a standard sample of 6-gingerol, a predominant substance among biologically active phenolic compounds of ginger, have been studied. It has been shown that its absorption spectrum in the range from 220 to 400 nm contains one absorption band with a maximum at 281 nm, which can be used as an analytical absorption band for the quantitative determination by absorption spectrophotometry.

2. It has been proven that excipients do not interfere with the quantitative determination of the total amount of phenolic compounds in the composition of tablets with a dry extract of ginger by the absorption spectrophotometry method since they do not absorb electromagnetic radiation in the region of the analytical maximum.

3. The method of the quantitative determination of the total amount of phenolic compounds calculated with reference to 6-gingerol by the method of direct one-wave absorption spectrophotometry with the subsequent calculation by the standard method has been developed.

4. According to the method developed it has been found that the content of the total amount of phenolic compounds calculated with reference to 6-gingerol in the experimental batch of tablets is 0.03556 ± 0.0088 g/tab. The relative uncertainty of the mean determination is 1.007 %.

Conflict of interests: authors have no conflict of interests to declare.

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