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Studies of Physico-Chemical and Pharmaco-Technological Properties of Zingiber Officinale Dry Extract

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Abstract

Diabetes mellitus (DM) is a serious medical and social problem for most countries in the world. Despite the wide application of synthetic medicines for diabetes mellitus treatment in the modern medicine, a special attention is paid to plant-based preparations. Phytopreparations possess high bioavailability, tolerability and also have fewer side-effects. According to the analysis of the literature on this issue, of special value due to its chemical composition, is Zingiber officinale.

Therefore, the **aim of** our work was to study the physico-chemical and pharmaco-technological properties of Zingiber officinale dry extract for the development of a sugar-lowering phytopreparation on its basis.

Materials and methods. To achieve this goal, methods of microscopic analysis, determination of moisture absorption, flowability, moisture content, bulk density, compressibility have been used.

Conclusions. It has been established by investigations that the dry extract of ginger is a hygroscopic powder, which shows the necessity of introducing moisture regulators. The results of pharmaco-technological studies indicate poor flowability and compressibility of the dry extract, which makes it possible to predict the introduction of antifriction and binding auxiliaries into the composition of solid dosage form.

Keywords: diabetes, dry extract, pharmaco-technological properties, tablets, Zingiber officinale.

INTRODUCTION

Diabetes mellitus (DM) is a serious medical and social problem for most countries in the world. Despite some efforts being made by WHO, health systems and governments, the prevalence of the disease is steadily increasing. In the world there are 450 million people diagnosed with diabetes mellitus, and in Ukraine – 1,2 million, of which 1 million are patients with type 2 diabetes [1].

Despite the broad use of synthetic drugs in modern medicine and pharmacy, the huge potential of phytotherapy for the treatment of diabetes has not been exhausted. Phytopreparations fully comply with all medical requirements and are not inferior to synthetic drugs in efficiency. They possess high bioavailability and tolerability, while they have fewer side effects, and differ by relative cheapness in comparison with synthetic drugs [2].

In folk medicine, according to the literature, such medicinal plant as ginger is widely used. It is known as a medicinal product and spice, which has a unique spicy, tart aroma and burning taste. Ginger has long been used in cooking, and in China and India it was considered capable of preserving youth, strengthening, warming and healing for colds, removing headaches, rheumatic and heart pains, relieving nausea, fatigue and apathy [3-5].

The value of ginger is in its rhizome, which contains a lot of essential oils and phenol-like substance gingerol. Zingiber officinale contains a complex mixture of pharmacologically active components such as flavonoids of various nature, β-carotene, capsaicin, curcumin, the full range of essential amino acids - tryptophan, threonine, leyzine, methionine, phenylanine, valine, as well as camphine, felandrin, cineole, borneol, citrol .The root is rich in B vitamins (B_1, B_2, B_{12}), C, A, salts of magnesium, calcium, phosphorus, also contains caffeic, caprylic, linoleic, nicotinic, oleic acids. In addition, ginger contains iron, zinc, potassium, sodium, aluminum, asparagine, calcium, choline, chromium, magnesium, manganese, silicon, phosphorus [6-9].

Nowadays, due to the chemical composition of the ginger root it is used as an antitussive, immunomodulating, anti-inflammatory, antioxidant and antitumor agent, also ginger is able to stimulate metabolic processes in the body, to lower the level of cholesterol and glucose in blood [3, 10-14].

Therefore, the aim of our work was to study the physico-chemical and pharmaco-technological properties of dry extract of Zingiber officinale for the development of a sugar-lowering phytopreparation on its basis.

MATERIALS AND METHODS

The object of the research was dry extract of Zingiber officinale (manufacturer "Medagroprom", Dnieper).

To develop a solid dosage form based on dry extract of ginger, its physicochemical and pharmacological properties were studied, such as:

- bulk volume and bulk density were studied on a device for vibration compacting of powders 545R-AK-3 - RT-TD manufactured by PHARMA TEST (Germany). A sample of 100 g of the test powder placed in the cylinder of the device and the volume readings were

recorded before settling and after 10, 500, and 1250 taps of the cylinder. Thus determined:

1) the ability to settle: $V_{10} - V_{500}$, ml;
2) density
   - bulk - density before settling $\rho_0 = m / V_0$ (g/ml);
   - density after settling $\rho_{1250} = m / V_{1250}$ (g/ml).
3) Carr Index $C = \frac{V_0 - V_{1250}}{V_0} * 100\%$
4) Hausner Ratio $HR = \frac{V_0}{V_{1250}}$

- fluidity and angle of repose were studied on the VP-12A device. At this a sample of 100 grams of dry extract of ginger with accuracy 0.5% was placed into the funnel of the device, closed at the bottom by a flap. The flap was then opened and the stopwatch was used to determine the time of the sample flowing out from the funnel with a hole diameter of 10 mm, after which the angle of natural slope of the flown powder was measured.
- moisture content was studied on the express moisture meter VT-500. At this placed inside the device extract was heated to 105 ± 1 °C and the display reflected the loss on drying. At the end of the process, the moisture content was displayed.
- moisture absorption at relative humidity of air of 45 %, 75 % and 100 % was studied with the help of a laboratory desiccator. Within 6 hours of the experiment a change in the mass of the powder was recorded. Relative humidity of air of 75 % was created with the help of a saturated solution of sodium chloride, 45 % – of potassium carbonate.
- crystallographic studies were carried out on a laboratory microscope "KONUS - Academy" with an eyepiece magnification of 40 times with an integrated camera [8, 11].
- to determine the compressibility of the powder, a 0.5 g sample was pressed in the matrix using a 12 mm diameter punch on a hydraulic press. After this, the strength of the obtained tablet was determined on PJ-3 Tablet Four-usage Tester (China).

Results And Discussion

According to the organoleptic analysis, dry extract of Zingiber officinale is a fine powder, light brown in color with characteristic odor.

When determining the moisture content of the extract, it was found that this figure meets SPU requirements and does not exceed 5 % (Table 1).

The study of the shape and size of the particles of the substance (Fig. 1) indicates that the powder has a non-uniform structure with transparent particles of light brown color, which are fragments of various shapes with a smooth surface, uneven edges, capable of agglomeration, ranging in size from 0.01 up to 0.7 microns, the form factor is 0.7. The result obtained, in turn, may indicate an insufficient flowability of the powder.

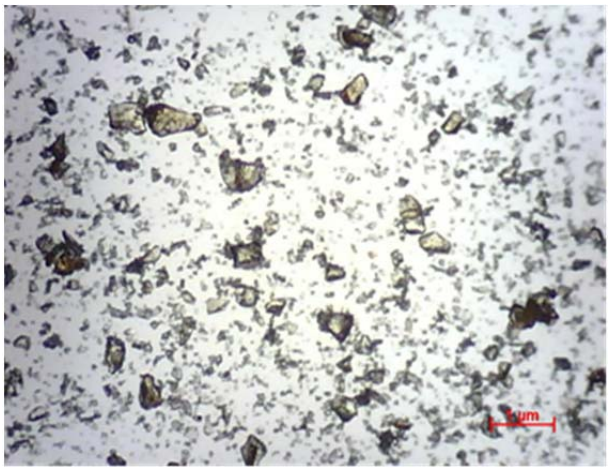

Figure 1 – Microscopy of dry extract of Zingiber officinale

As is known, one of the drawbacks of dry extracts is their high hygroscopicity [15]. Therefore, the next stage of our work was the study of hygroscopicity of Zingiber officinale dry extract. Based on the results of the experiment, it was found that, at a relative air humidity of 100 % (Fig. 2), after 6 hours of the experiment, the moisture content increased to 14 %, and after 48 hours the substance dissolved. At humidity of 45 % moisture content after 6 hours of the experiment increased to 4.45 %, and at 75 % to 7.94 %. Thus, the conducted studies indicate the need to introduce moisture regulators in the development of solid dosage forms based on a dry extract of Zingiber officinale.

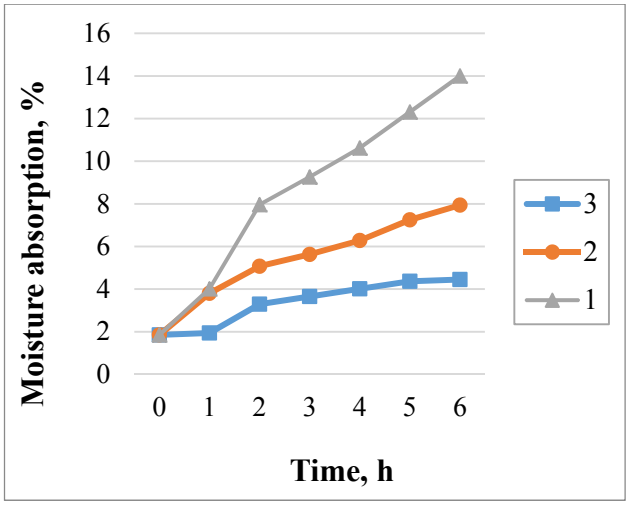

Figure 2 – Influence of relative humidity of air on moisture absorption of the substance: 1 – 100 %; 2 – 75 %; 3 – 45 %

The next stage of our research was the study of the bulk volume and bulk density of the substance. The obtained bulk density results indicate that the dry extract of ginger refers to the average density powders (ρ_{max} = 1.11), which can lead to an inhomogeneous distribution of the extract particles in the volume of the solid dosage form.

As is known, one of the most important indicators of the powder system is its flowability, which ensures a uniform filling of the matrix channel. The calculated

indices of Hausner – 1.44 and Carr – 30.77 indicate unsatisfactory flowability, which was confirmed by experimental data. It was found that the extract did not flow out of the funnel with a hole of 1.5 mm without vibration. When exposed to vibration, the flowability improved (1.35 g/s), but not significantly. The obtained results confirm the data of the microscopic analysis of the substance. Thus, the development of a solid dosage form based on a dry extract of ginger requires the introduction of antifriction auxiliaries.

Pressability of a powder is an indicator of the ability of its particles to interlock under pressure with the formation of a firm and strong compact. To study this index, model samples with a diameter of 12 mm were made. As can be seen from the data given in Table 1, ginger extract has an insufficient value of compressibility – less than 50 N. Therefore, in the development of tablets, it is rational to use binding auxiliary substances.

Table 1: Pharmaco-technological properties of Zingiber officinale dry extract

Parameter	Units	Research results
Bulk volume before tapping, V_0	ml	130 ± 0.8
Volume after tapping, V_{10}	ml	122 ± 1.8
Volume after tapping, V_{500}	ml	92 ± 0.32
Volume after tapping, V_{1250}	ml	90 ± 0.26
Settling ability, V_{10} - V_{500}	-	30 ± 0.5
Density before tapping, m/V_0	g/ml	0.769 ± 0.03
Density after tapping, m/V_{1250}	g/ml	1.111 ± 0.02
Carr Index	%	30.77 ± 0.01
Hausner Ratio	-	1.44 ± 0.01
Flowability	sec/100 g	∞
Humidity	%	1.85 ± 0.02
Pressability	N	42 ± 1.2

Note: n = 5, P = 95 %

CONCLUSIONS

- on the basis of literature data, the properties of Zingiber officinale have been characterized, which confirms the relevance and prospects of its use for the development of hypoglycemic action drugs;

- it has been found that the dry extract of Zingiber officinale is a hygroscopic powder. At 100 % relative humidity, the moisture increase in the sample was 14 % with a further change in appearance. The obtained data testify to the necessity of moisture regulators introduction;

- results of pharmaco-technological studies indicate poor flowability and compressibility (42 N), which is due to the physicochemical features of the dry extract of ginger. These studies make it possible to predict the introduction of antifriction and binding excipients into the formulation of a solid dosage form.

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