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HYPOGLYCEMIC AND ANTILIPIDEMIC POTENTIAL OF NON-ALKALOID FRACTION FROM *GALEGA OFFICINALIS* EXTRACT IN EXPERIMENTAL DIABETES MELLITUS

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Introduction. Dyslipidemia is a significant risk factor for cardiovascular disease in patients with diabetes mellitus, especially of type 2. The search for biologically active compounds derived from natural products capable of correcting lipid metabolism is a promising direction in the development of effective and safe dyslipidemia therapy. This study compared the hypoglycemic and antilipidemic potential of the non-alkaloid extract of *Galega officinalis* and the official herbal medicinal product Arfazetyn under experimental diabetes mellitus.

Materials and Methods. Experimental diabetes mellitus was induced by intraperitoneal administration of streptozotocin. The study utilized a non-alkaloid fraction of *Galega officinalis* extract stabilized with biosurfactants – products of *Pseudomonas* sp. PS-17 biosynthesis – and the official herbal preparation Arfazetyn. To assess the hypoglycemic effect of the *G. officinalis* extract and Arfazetyn, glycated haemoglobin and blood glucose levels were measured, an oral glucose tolerance test was performed, and the area under the glycemic curves was calculated. To evaluate the corrective effect of the investigated herbal preparations on lipid metabolism, lipid profile analysis was conducted (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides).

Results. The results indicate that the non-alkaloid fraction of *Galega officinalis* extract effectively lowers blood glucose and glycated hemoglobin levels to within the physiological range, while also improving glucose tolerance under experimental diabetes mellitus conditions. Moreover, this extract demonstrated a higher hypoglycemic potential than the official herbal medicinal product Arfazetyn. Additionally, administration of the *G. officinalis* extract contributed to normalizing total cholesterol, low-density lipoprotein cholesterol, decreasing triglycerides, and increasing high-density lipoprotein cholesterol content.

Conclusion. The established hypoglycemic potential of the non-alkaloid fraction of *Galega officinalis* extract, its ability to correct manifestations of dyslipidemia under experimental diabetes mellitus, confirms its therapeutic potential in managing lipid disorders and reducing associated cardiovascular risks.

Keywords: diabetes mellitus, non-alkaloid fraction extract of *Galega officinalis*, hypoglycemic and antilipidemic effects

INTRODUCTION

Diabetes mellitus (DM), especially of type 2, is associated not only with hyperglycemia but also with severe lipid metabolism disorders, including dyslipidemia. This creates additional risks of cardiovascular disease, which remains the primary cause of death in people with type 1 or type 2 diabetes (Miller *et al*., 2019; Schmidt, 2019).

It is well known that the lipid profile of patients with DM is characterized by increased triglyceride (TG) levels, reduced high-density lipoprotein cholesterol (HDL-C) concentrations, and low-density lipoprotein cholesterol (LDL-C). Recent studies, however, suggest that these lipid abnormalities may not solely result from diabetes but could also contribute to the disruption of glucose (Parhofer, 2015).

The most prevalent blood lipid abnormality in populations of diabetics is hypertriglyceridemia (Bethelli & Oroszi, 2023). Elevated triglyceride levels contribute to an increase in circulating free fatty acids, which in turn may lead to the development of insulin resistance and impaired β-cell function (Ebbeling *et al*., 2022). Free fatty acids also act as key regulators of inflammatory processes, making hypertriglyceridemia a potential trigger of chronic subclinical inflammation. This inflammation is considered one of the mechanisms contributing to insulin resistance and β-cell dysfunction. The impact of hypertriglyceridemia on glucose metabolism is of significant clinical relevance, as it helps explain why patients with elevated triglyceride levels often struggle to achieve effective glycemic control. It also clarifies why patients typically require less intensive antidiabetic therapy once hypertriglyceridemia is resolved.

Despite progress in therapeutic approaches, only modest improvements have been achieved in the long-term prevention and management of cardiovascular disease, especially among individuals with diabetes mellitus, with morbidity and mortality rates remaining relatively elevated (Ebbeling *et al*., 2022).

Traditional pharmacological treatments, including statins and fibrates, have shown efficacy but are often accompanied by side effects and long-term safety concerns. In addition, unsatisfactory therapeutic effect and drug resistance were also found in some patients (Hu *et al*., 2022).

In recent years, attention has increasingly turned to natural compounds and plant-derived extracts as alternative or complementary therapies for metabolic disorders (Tran *et al*., 2020).

The combined use of medicinal plant-based products with synthetic antidiabetic agents or insulin can provide faster achievement of diabetes compensation, as well as a reduction in the dose of insulin or oral hypoglycemic agents. In addition, the evaluation of the effectiveness of the correction of metabolic disorders in diabetes using plant sources creates prospects for the development of effective non-toxic antidiabetic drugs (Tran *et al*., 2020).

One of the most promising antidiabetic medicinal plants is *Galega officinalis*, which, due to its rich content of biologically active compounds, has hypoglycemic, antilipidemic, antioxidant and antiinflammatory effects (Angouti *et al*., 2024; Hu *et al*., 2022; Sukhtezari *et al*., 2024; Bednarska *et al*., 2020).

The aim of this study was to investigate the hypoglycemic potential and the ability to correct manifestations of dyslipidemia by bioactive compounds from the non-alkaloid extract of *G. officinalis*, as well as to compare the antidiabetic efficacy of this extract with the well-known reference phytopreparation – Arfazetyn.

MATERIALS AND METHODS

The research object. For the experiments, 4–5 month-old male Wistar rats (160 to 250 g) were used. The animals were kept in standard vivarium conditions in compliance with the general ethical principles of conducting experiments on animals in accordance with the "General Principles for the Welfare of Animals" approved by the First National Congress on Bioethics (Kyiv, Ukraine, 2001) and agreed with the provisions of the "European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes" (Strasbourg, France, 1985) and additionnally approved by the Ethics Committee of Ivan Franko National University of Lviv, Ukraine (protocol No. 50-04-2025 from 14 April 2025).

Rats were randomly divided into the groups: 1 – control animals (C); 2 – animals with experimental DM; 3 – animals with experimental DM that were administered non-alkaloid extract *G. officinalis* (NAEGO) (DM + NAEGO) for 14 days; 4 – animals with experimental DM that were administered the official herbal collection Arfazetyn (DM + A) for 14 days. The non-alkaloid extract of *G. officinalis* was administered to rats *per os* at doses 0.6 g/kg (one dose per day) daily for 14 days. We described the methods for obtaining and stabilizing the NAEGO using surfactants of biological origin (Dub & Klishch, 2019; Jacob *et al.*, 2022) synthesized by bacteria *Pseudomonas* sp. PS-17, as well as the analysis of its composition by components in our previous studies (Lupak *et. al*., 2015). Arfazetyn was administered at a dose of 16 mL/kg of body weight (Dub & Klishch, 2019; Jacob *et al*., 2022).

Induction of experimental diabetes mellitus. Experimental DM was induced by intraperitoneal administration of streptozotocin dissolved in citrate buffer (10 mM, pH 5.5) at a dose of 0.055 g/kg of body weight. The development of DM was monitored by blood glycemia level. Animals with blood glucose levels ≥ 12 mM were used in the experiment.

Preparation and stabilisation of *G. officinalis* extract by addition of ramnolipid biocomplex (*Pseudomonas* sp.) PS-17. The extract of *G. officinalis* was prepared by infusion of the plant material (leaves and stems) in 96% ethanol (1:5). The extraction was carried out for 18 hours at a temperature of 20–23 °C. The ethanolic extract was then evaporated (under vacuum at 50–55 °C) using a rotary evaporator Laborota 4001

(Heidolph, Schwabach, Germany). The evaporation procedure was carried out until a dense residue extract was obtained. The percentage yield of the crude extract was estimated at 15–17%. To obtain the non-alkaloid fraction of the ethanolic extract, an equal amount of H_2O and $CHCl_3$ was added. The mixture obtained was carefully shaken and then centrifuged (10 min, 600 g). The chloroform fraction of the ethanolic extract obtained in this way was evaporated (under vacuum at 40–45 °C) until a solid residue was obtained. The estimated percentage yield of the chloroform fraction was 3,3–5 %. Rhamnolipid biocomplex (surfactant synthesized by *Pseudomonas* sp. PS-17 strain) was used to stabilise the chloroform fraction. Rhamnolipid biocomplex PS-17 was added to the obtained solid residue of the chloroform fraction of *G. officinalis* extract at a concentration of 3.3 g/L. The chemical composition of non-alkaloid fractions from *G. officinalis* extract before and after stabilization were investigated (Lupak *et al*., 2015). The non-alkaloid extract of *G. officinalis* was standardised by the polyphenol content, which is 28.8±2.5 mg GA/g extract (Hachkova *et al*., 2021; Lupak *et al.*, 2015). The dose of the NAEGO was chosen on the basis of our previous studies, which confirmed its hypoglycemic effect (Hachkova *et al*., 2021).

Total phenolic compound content analysis. Follin–Ciocalteu method was used for the analysis of total phenolic compound (TPC) content. Phenol compounds when interacting with a Follin–Ciocalteu reagent (containing sodium tungstate, sodium molybdate, lithium sulfate, phosphoric and hydrochloric acids) forms a green-blue colored compound that was analyzed spectrophotometrically (765 nm). TPC content was expressed as gallic acid equivalent per 1 g of extract (mg GAE/g) (Hachkova *et al*., 2021; Gao *et al.*, 2000).

Administration of Arfazetyn to animals. Arfazetyn (Liktravy Private Joint Stock Company, Ukraine) is a standardized multicomponent herbal mixture traditionally and officially used to support carbohydrate and lipid metabolism, particularly in individuals with type 2 DM. The formulation includes the following medicinal plants: *Phaseoli fructus* sine semine (bean pods), *Inulae helenii* radix (elecampane root), *Hyperici herba* (St. John's wort herb), *Rosae fructus* (rosehip fruits), *Equiseti arvensis* herba (field horsetail herb), *Polygoni avicularis* herba (knotgrass herb), *Glycyrrhizae radix* (licorice root), and *Vaccinii myrtilli* folia (bilberry leaves). These components are rich in flavonoids, phytosterols, phenolic compounds, and other biologically active substances, contributing to the hypoglycemic, anti-inflammatory, antioxidant, and lipid-lowering effects of the preparation. Arfazetyn is the only herbal medicine with proven antihyperglycemic activity that is registered as a drug and approved for use in Ukraine as part of a combination therapy for type 2 diabetes.

Five grams of the plant material were infused by pouring 200 mL of boiling water and infused in a boiling water bath for 15 minutes. It was cooled at room temperature and filtered. The volume of the infusion was brought up to 200 mL with boiled water. The dose of the comparator in animals was calculated using the species sensitivity coefficient, taking into account the average daily therapeutic dose for humans (Dub & Klishch, 2019; Jacob *et al*., 2022).

Determination of blood glucose concentration. Glucose concentration was determined by the glucose oxidase method, according to the instructions of the analytical kit for enzymatic determination of blood glucose "Philisit-Diagnostics" (Ukraine).

Glucose tolerance test assay. The glucose tolerance test (GTT) was performed in the morning after 18-hour fasting of the animals. Glucose levels were determined

from the rat's tail vein blood before and after the carbohydrate load. The glycemic curves were constructed based on the obtained results. The obtained curves show the rate of glucose assimilation and how the introduction of extracts affects the blood glucose level (the zero points are on an empty stomach and after glucose intake every ten minutes in a range from 10 to 120 min). The integral index of the area under the curve for plasma glucose (AUCglu) shows a general increase in glucose concentrations after glucose consumption. This index serves as the criterion for the total response to the standard glucose tolerance test. The AUCglu was calculated by the trapezoid rule (Yeh, 2002).

Blood plasma collection. Blood : heparin (1:100) was centrifuged for 15 minutes at 3000 rpm at a temperature of 4 °C to separate plasma. The plasma was carefully removed from the sediment after centrifugation.

Determination of glycated hemoglobin (HbA1c) content. The content of HbA1c in erythrocytes was determined by the colorimetric method, which is based on acid hydrolysis of the ketamine bond in the presence of oxaloacetate. The reaction produces 5-oxymethylfurfural, which, interacting with 2-thiobarbituric acid (TBA), forms a colored complex, the intensity of which is determined on a spectrophotometer at a wavelength of 443 nm (Sherwani *et al*., 2016; Kampen *et al*., 1983).

Measurement of lipoproteins content. The lipid profile (total cholesterol (TC), LDL-C, HDL-C, and TG in rat serum was analyzed using commercial kits of reagents (Philisit-Diagnostics, Ukraine).

Triglycerides. To 0.01 mL of plasma was added 1 mL of enzyme reagent $1500 \cdot 10^6$ U/L lipase, $200 \cdot 10^6$ U/L glycerol kinase, $1000 \cdot 10^6$ U/L glycerol phospate oxidase, $250 \cdot 10^6$ U/L peroxidase, 40 mmol/L PIPES, pH 7.5, 5 mmol/L 4-chlorophenol, 1 mmol/L $MgSO_4$ $1500 \cdot 10^6$ U/L lipase, $200 \cdot 10^6$ U/L glycerol kinase, $1000 \cdot 10^6$ U/L glycerol phospate oxidase, and $250 \cdot 10^6$ U/L peroxidase 0.5 mmol/L 4-aminophenazone) and incubated at 37 °C for 10 min. The absorbance of the samples was measured at 505 nm. The standard sample contained 0.01 mL of 2.26 mmol/L TG and 1 mL of the enzyme reagent. The results were expressed in mmol/L.

Cholesterol. To 0.01 ml of plasma was added 1 mL of enzyme reagent (containing 150 U/L choline esterse, 100 U/L cholesterol oxidase, 5000 U/L peroxidase, 0.3 mmol/L 4-aminophenazone, 30 mmol/L phenol, and 30 mmol/L Tris) and incubated at 37 °C for 10 min. The absorbance of the samples was measured at 500 nm. The standard sample contained 1 mL of enzyme reagent and 0.01 mL of 5.17 mmol/L cholesterol. The results were expressed in mmol/L.

High-density lipoprotein-cholesterol. The method of HDL-C determination is based on the precipitation of other lipoproteins, leaving HDL-C available for the enzymatic reaction. LDL-C, very-low-density lipoprotein cholesterol (VLDL-C) and chylomicrons, were precipitated by addition 0.5 mL of precipitation reagent to 0.25 mL of plasma. The mixture was allowed to stand for 10 minutes at room temperature (20–25 °C) and centrifuged at 7000 g. HDL-C remained in the supernatant and was determined enzymatically using a cholesterol determination kit.

Low-density lipoprotein-cholesterol. The masking reagent binds to LDL-C and protects LDL-C from enzyme reactions. Cholesterol esterase and cholesterol oxidase react with non-LDL-C (chylomicrons, VLDL-C and HDL-C), hydrogen peroxide produced

by the enzyme reaction, is decomposed by catalase. The second step releases cholesterol from LDL-C, which was determined by an enzymatic method using the detection kit to determine cholesterol content.

Statistical analysis of results. The basic statistical parameters were calculated using direct quantitative data obtained from the study (arithmetic mean – M, the standard deviation of the arithmetic mean – m). To assess the statistical significance of differences between two data sets, we performed one-way analysis of variance (ANOVA) followed by post-hoc tests. Pairwise comparisons were made using Tukey's or Dunnett's tests. The difference was considered significant under $p \geq 0.95$ (the level of significance $P < 0.05$).

RESULTS AND DISCUSSION

The biological effects of non-alkaloid extract of *G.officinalis* were evaluated in comparison with the reference herbal preparation Arfazetyn. Under the conditions of experimental DM, pronounced hypoglycemic effect of both the non-alkaloid extract of *G. officinalis* and Arfazetyn was established (**Fig. 1–2**).

In addition to being used for DM diagnosis, the oral GTT is also informative for evaluating the effectiveness of hypoglycemic agents. To quantitatively assess the overall increase in blood glucose concentration following glucose loading, we calculated the AUCglu. It was found that the administration of a non-alkaloid extract of *G. officinalis* significantly improves glucose tolerance, as evidenced by a decrease in AUCglu by 55.9 % and 55.6 % in diabetic animals treated with *G. officinalis* extract and the reference drug Arfazetyn, respectively (**Fig. 1**, ***A–B***).

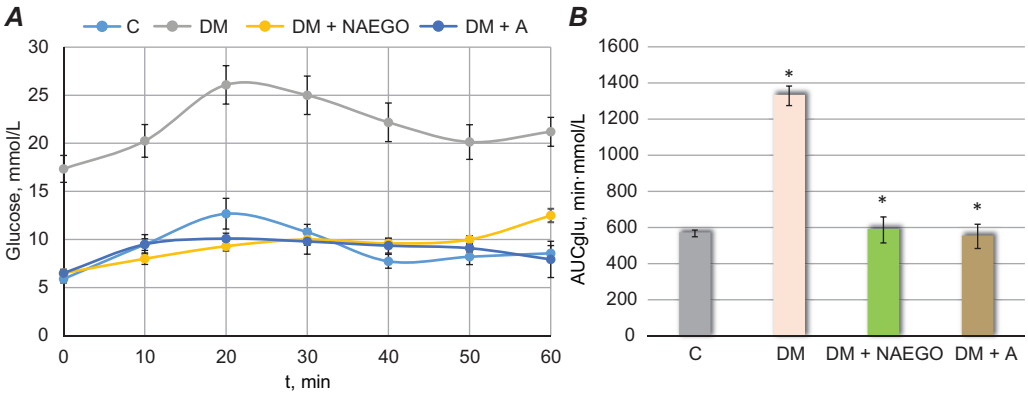

Fig. 1. Glycemic curves after a glucose load (***A***) and the area under glycemic curves (***B***) in control (C), diabetes mellitus (DM), and after administration of non-alkaloid of *G. officinalis* extract (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, $P < 0.05$; # – significant difference compared to DM, $P < 0.05$

Administration of *G. officinalis* extract and Arfazetyn to diabetic animals resulted in a 63 % and 53 % reduction in blood glucose concentration compared to the diabetes group (**Fig. 2**).

Glycated hemoglobin provides a reliable measure of chronic glycemia and correlates well with the risk of long-term diabetes complications (Sherwani *et al.*, 2016).

In diabetic rats, persistent hyperglycemia led to a 66 % increase in HbA1c levels compared to the control group. *G. officinalis* extract caused a decrease by 41 % in HbA1c content in animals with the studied pathology. Arfazetyn also reduced the HbA1c content (by 21 %), but not as effectively as *G. officinalis* extract (**Fig. 3**).

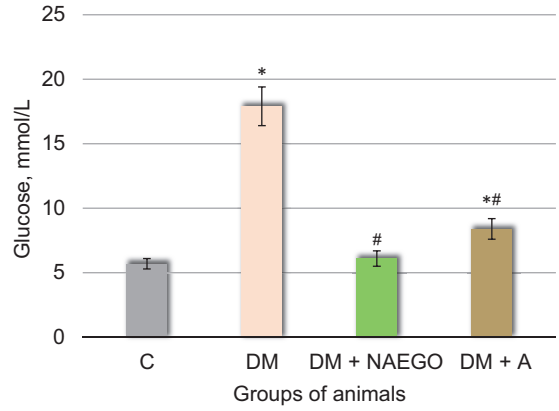

Fig. 2. The glucose concentration in control (C), diabetes mellitus (DM), and after administration of non-alkaloid fraction of *G. officinalis* extract (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

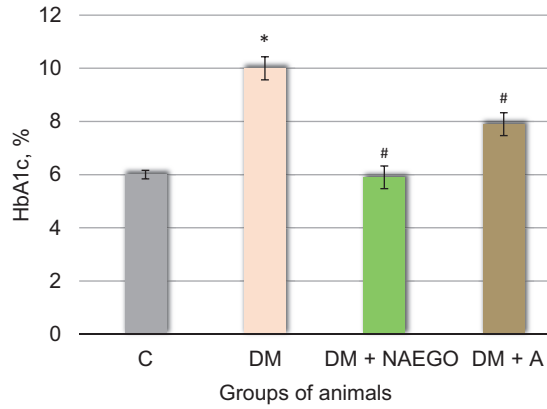

Fig. 3. The glycated hemoglobin concentration in control (C), diabetes mellitus (DM), and after administration of non-alkaloid extract of *G. officinalis* (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

Impaired carbohydrate metabolism is combined with marked changes in lipid metabolism in DM, which leads to the development of atherosclerosis and macrovascular complications. The characteristic signs of dyslipidemia in patients with DM, in particular of type 2, include increased levels of TG, cholesterol, LDL-C, as well as a decrease in the content of HDL-C.

As a result of the conducted experiments, it was established that the development of streptozotocin-induced diabetes leads to a 45 % increase in TG content in rat blood plasma. Such changes in lipid metabolism may be a consequence of hyperglycemia. It was found that the administration of non-alkaloid extract led to a 33 % reduction in TG levels compared to the diabetic group; however, this effect was less pronounced than that observed with the use of Arfazetyn. The higher efficacy of Arfazetyn in reducing TG levels may be attributed to the potent combined pharmacological action of the biologically active substances present in its composition (**Fig. 4**).

HDL-C is a lipoprotein formed in the liver and, partially, in the small intestine in the form of lipid discs consisting of phospholipids, free cholesterol, and apo E and

apo C. HDL-C prevents excessive accumulation of cholesterol in cells, which is why it is referred to as an antiatherogenic lipoprotein.

We found that in animals with experimental DM, the HDL-C content in blood plasma decreased by 38 % compared to the control group. Following the administration of *G. officinalis* extract and Arfazetyn to diabetic animals, a moderate increase in HDL-C levels was observed by 19 % and 23 %, respectively. These findings suggest a comparable effectiveness of both phytopreparations in restoring HDL-C levels (**Fig. 5**).

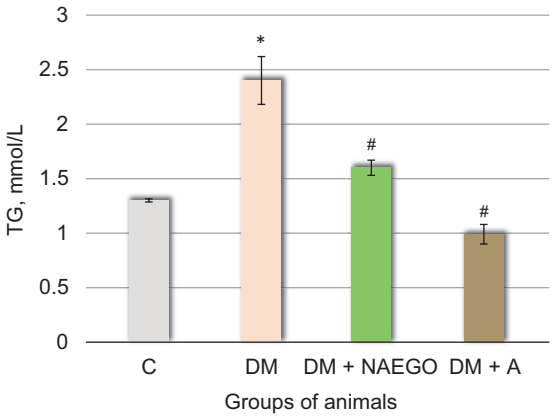

Fig. 4. The content of TG in the blood plasma in control (C), experimental diabetes mellitus (DM), and after administration of non-alkaloid extract of *G. officinalis* (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

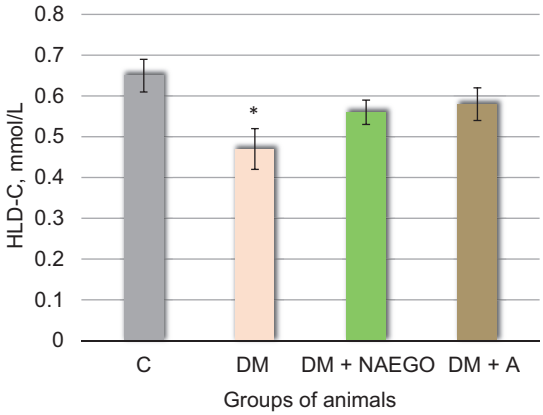

Fig. 5. The content of HDL in the blood plasma in control (C), diabetes mellitus (DM), and after administration of non-alkaloid fraction *G. officinalis* extract (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

LDL-C contains the most significant amount of cholesterol and is the main class of human plasma lipoproteins that carry cholesterol. Impaired LDL-C metabolism is the biochemical basis of many severe lipid metabolic disorders. Given that cholesterol can penetrate the vascular wall as part of LDL-C, a high concentration of these lipoproteins in human blood plasma is considered a factor contributing to the development of atherosclerosis.

In animals with experimental DM, plasma LDL-C content increased by 76 % compared to control. The administration of Arfazetyn to diabetic animals reduced LDL-C levels in blood plasma more effectively than administration of the non-alkaloid fraction of *G. officinalis* extract to the same group. Moreover, treatment of control animals with NAEGO led to a 26 % reduction in LDL-C cholesterol compared to the untreated control group, and a 28 % decrease compared to the DM group (**Fig. 6**).

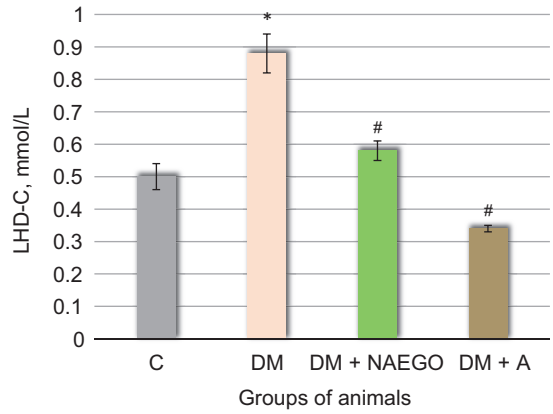

Fig. 6. The content of LDL in the blood plasma in control (C), diabetes mellitus (DM), and after administration of non-alkaloid *G. officinalis* extract (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

The obtained data confirm positive effect of the non-alkaloid *G. officinalis* extract on the LDL-C content in the blood plasma of animals with experimental DM. Specifically, LDL-C levels decreased by 34 % compared to the diabetic group, approaching physiological norm values. In response to Arfazetyn administration, LDL-C levels also reduced in animals with experimental DM, but to a greater extent, by 62 % compared to *G. officinalis* extract, and also showed a reduction in the control group.

In conditions such as liver and kidney disease or diabetes, cholesterol levels tend to rise significantly, increasing the risk of atherosclerosis and vascular damage. It was found that administration of *G. officinalis* extract to diabetic animals resulted in a 20 % reduction in total cholesterol levels, returning them to near-control values. Administration of Arfazetyn led to a more pronounced decrease in cholesterol content, both in diabetic animals (by 39 %) and in control animals (by 25 %) (**Fig. 7**).

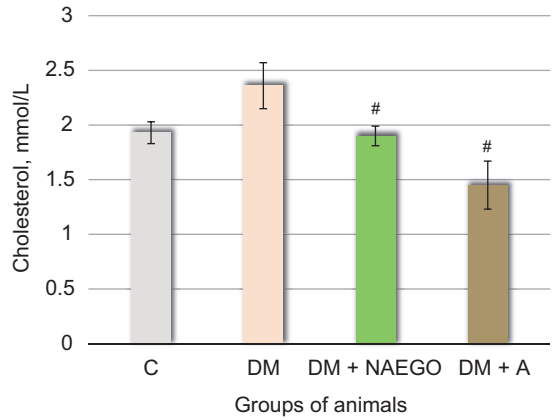

Fig. 7. Cholesterol content in the blood plasma in control (C), diabetes mellitus (DM), and after administration of non-alkaloid extract of *G. officinalis* (NAEGO) and Arfazetyn (A)

Note: * – significant difference compared to control, P <0.05; # – significant difference compared to DM, P <0.05

The administration of NAEGO to animals with DM corrects the antiatherogenic lipids – HDL-C content at a level comparable to the reference preparation, the herbal blend Arfazetyn. However, it is less effective in modulating the levels of atherogenic lipids, such as cholesterol, TG, and LDL-C. In addition, the normalisation of carbohydrate metabolism by the biologically active substances of *G. officinalis* may contribute to the improvement of lipid metabolism, thereby facilitating the correction of dyslipidemia.

Literature data indicates that the correction of lipid metabolism disorders with the help of herbal remedies and dietary supplements is mediated mainly by reducing the expression and activity of β-hydroxy-β-methylglutaryl-CoA reductase (HMG-CoA reductase). HMG-CoA reductase is a key enzyme that limits the rate of cholesterol biosynthesis (Olatoye, 2025).

Some biologically active compounds of natural origin, including polyphenols, flavonoids, and phenolic acids, have been shown to inhibit HMG-CoA reductase either directly by binding to its active site or indirectly by modulating transcription factors such as SREBP-2 or activating AMPK signalling pathways (Olatoye, 2025; Wong *et al*., 2015). These mechanisms contribute to their hypolipidemic and potential antiatherogenic effects.

We attribute the decrease in the content of atherogenic lipid forms in the blood plasma of animals treated with *G. officinalis* extract to the presence of flavonoids – kaempferol, myricitin (Ojha *et al*., 2015), quercitin (Lee *et al*., 2018), luteolin (Goyal & Hammes-Schiffer, 2015) and phenolic acids – ferulic and gallic (Bumrungpert *et al*., 2018), which have been experimentally confirmed to have an inhibitory effect on the activity of β-HMG-CoA reductase.

Increasing the level of HDL-C is essential in preventing cardiovascular diseases. The literature describes the activation of PPAR-α and PPAR-γ nuclear receptors by polyphenols, which leads to the activation of the expression of genes whose products regulate HDL-C levels. Quercitin activates PPAR-γ nuclear receptors, which increases the expression of transport proteins ABCA1 and ABCG1, involved in the reverse transport of cholesterol, and improves the antioxidant properties of HDL-C (Enayati *et al*., 2022) including cellular differentiation, metabolic syndrome, cancer, atherosclerosis, neurodegeneration, cardiovascular diseases, and inflammation related to their up/downstream signaling pathways. Consequently, several types of selective PPAR ligands, such as fibrates and thiazolidinediones.

CONCLUSIONS

It was found that the antihyperglycaemic effect of the non-alkaloid extract of *G. officinalis* is not inferior to that of the official phytopreparation Arfazetyn, and the impact of this extract on the content of glycosylated hemoglobin under conditions of experimental DM significantly exceeds the effectiveness of the comparison drug. The more effective corrective effect of *G. officinalis* extract, compared to the multicomponent herbal medicine Arfazetyn, indicates the presence of components with more pronounced hypoglycemic properties in this extract.

In a model of streptozotocin-induced diabetes mellitus, it was shown that of the non-alkaloid extract of *G. officinalis* modulated the level of HDL-C antiatherogenic lipid fractions at a level comparable to Arfazetyn. However, it was less effective than the reference preparation in correcting the levels of atherogenic lipids, including total cholesterol, TG, and LDL-C.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: the authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

Human Rights: this article does not contain any studies with human subjects performed by any of the authors.

Animal studies: all international, national, and institutional guidelines for the care and use of laboratory animals were followed.

AUTHOR CONTRIBUTIONS

Conceptualization, [H.H.; S.N.]; methodology, [H.H.; P.T.]; validation, [H.H.]; formal analysis, [H.H.].; investigation, [P.T.; H.H.]; resources, [P.T.; H.H.]; data curation, [H.H.]; writing original draft preparation, [H.H.; S.N.]; writing – review and editing, [H.H.; S.N.]; visualization, [H.H.]; supervision, [S.N.]; project administration, [H.H.; S.N.]; funding acquisition, [-].

All authors have read and agreed to the published version of the manuscript.

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ГІПОГЛІКЕМІЧНИЙ І АНТИЛІПІДЕМІЧНИЙ ПОТЕНЦІАЛ БЕЗАЛКАЛОЇДНОЇ ФРАКЦІЇ ЕКСТРАКТУ КОЗЛЯТНИКА ЛІКАРСЬКОГО ЗА УМОВ ЕКСПЕРИМЕНТАЛЬНОГО ЦУКРОВОГО ДІАБЕТУ

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Обґрунтування. Дисліпідемія є важливим чинником ризику серцево-судинних захворювань у пацієнтів з цукровим діабетом, особливо 2-го типу. Пошук біологічно

активних сполук, отриманих із природних продуктів, здатних коригувати ліпідний обмін, є перспективним напрямом у розробці ефективної та безпечної терапії дисліпідемії. У цьому дослідженні проведено порівняльний аналіз гіпоглікемічного й антиліпідемічного потенціалу безалкалоїдної фракції екстракту козлятника лікарського й офіцинального лікарського засобу рослинного походження Арфазетину за умов експериментального цукрового діабету.

Матеріали та методи. Експериментальний цукровий діабет індукували внутрішньоочеревинним введенням стрептозотоцину. У дослідженні використовували безалкалоїдну фракцію екстракту козлятника лікарського, стабілізованого біосурфактантом, який є продуктом біосинтезу *Pseudomonas* sp. PS-17i референс-препарат – фітозбір Арфазетин. Для аналізу гіпоглікемічної дії безалкалоїдної фракції екстракту козлятника лікарського й Арфазетину визначали вміст глікованого гемоглобіну та глюкози у крові проводили пероральний глюкозотолерантний тест і розраховували площу під глікемічними кривими. Для з'ясування коригуючого впливу досліджуваних рослинних препаратів на ліпідний обмін проводили аналіз ліпідного профілю (загальний холестерол, холестерол ліпопротеїнів низької щільності, холестерол ліпопротеїнів високої щільності, тригліцериди).

Результати. Отримані результати свідчать про те, що безалкалоїдна фракція екстракту козлятника лікарського ефективно знижує рівень глюкози та глікованого гемоглобіну у крові щурів до рівня фізіологічних значень і покращує толерантність до глюкози у щурів за умов експериментального цукрового діабету. До того ж цей екстракт продемонстрував вищий гіпоглікемічний потенціал, ніж офіцинальний лікарський препарат рослинного походження Арфазетин. Крім того, прийом безалкалоїдної фракції екстракту козлятника лікарського сприяв нормалізації вмісту загального холестеролу, холестеролу ліпопротеїнів низької щільності, зниженню тригліцеридів та підвищенню вмісту холестеролу ліпопротеїнів високої щільності.

Висновок. Встановлений гіпоглікемічний ефект безалкалоїдної фракції екстракту козлятника лікарського, а також його здатність коригувати прояви дисліпідемії за умов цукрового діабету, підтверджують його антидіабетичний потенціал. Отримані результати підтверджують доцільність подальшого вивчення цього екстракту, з метою розробки на його основі фітопрепаратів, які знижуватимуть рівень глюкози у крові та коригуватимуть дисліпідемію за умов цукрового діабету.

Ключові слова: цукровий діабет, безалкалоїдна фракція екстракту козлятника лікарського, гіпоглікемічний ефект, антиліпідемічний ефект

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