ISSN: 3066-8123
Research Article

Science Set Journal of Cardiology Research

Cardiotropic Activity of Cyclosiversioside F from Astragalus Pterocephalus

Agzamova M A[1]* & Imamaliev B A[2]

[1]*Institute of the Chemistry of Plant Substances named after akad. S.Yu.Yunusova AS RUzbekistan Tashkent, fax (99871) 120 64 75*
[2]*LLC Scientific Centre "MED STANDART" of Republic Uzbekistan*

***Corresponding author:** Agzamova M A, 1Institute of the Chemistry of Plant Substances named after akad. S.Yu.Yunusova AS RUzbekistan Tashkent, fax (99871) 120 64 75.

Submitted: 26 June 2025 **Accepted:** 03 July 2025 **Published:** 10 July 2025

https://doi.org/10.63620/MKSSJCR.2025.1027

***Citation:** Agzamova M A., Imamaliev B A. (2025). Cardiotropic Activity of Cyclosiversioside F from Astragalus Pterocephalus. Sci Set J of Cardiology Res, 4(4), 01-06.*

Abstract

***Annotation:** Plants of the genus Astragalus are a source of triterpene glycoside of the cycloartane series. Cyclosiversioside F was isolated from A.pterocephalus that grows in Uzbekistan. Preclinical studies of the drug Cyclosiversioside F have been carried out on the indicator of cardiotonic activity. Cardiotropic and anti-ischemic activity has been established; it is not inferior to the reference drug, and in some cases exceeds it.*

Keywords: Astragalus Pterocephalus, Cyclosiversioside F, Cycloartane Glycoside, Cardiotropic, Mildronate.

Introduction

Nature is rich in biologically active compounds with a variety of structures and activities that have great potential for creating new drugs. Isolating natural metabolites and directing them in the right direction is the task of chemists and pharmacologists. Higher plants are sources of secondary metabolites such as alkaloids, phenols, terpenes and coumarins, which are active compounds. The phytochemical potential of plants in Central Asia is rich and diverse. Plants containing cycloartane triterpenoids and glycosides have been widely used in traditional medicine for various diseases. Some members of this class have hypolipedemic, hypotensive, diuretic, anti-inflammatory, sedative, analgesic, immunostimulation, and cardiotonic activities.

Astragalus pterocephalus Bunge is a source of cycloartane series triterpenoids. This plant species is widespread in the Republic of Uzbekistan - there are about 250 ones [1].

The purpose of this article is to isolate triterpene glycoside of the cycloartane series from plant materials of A.pterocephalus and to study its cardiotonic activity. We studied the chemical composition of the plant Astragalus pterocephalus Bunge for the content of steroid and terpenoid components [2, 3].

For the first time, cycloartane glycosides were discovered in plants of the genus Astragalus, at the Institute of the Chemistry of Plant Substances of the Academy Sciences of Republic Uzbekistan. Cycloartane glycosides are a group of substances with polyfunctional chemical structures. The possibility of using modern methods of screening biologically active compounds contributes to the increasing interest in plants as potential sources of new drugs. Drugs based on triterpenoids have a pronounced cardiotonic effect and contribute to the improvement of left ventricular function in patients with congestive heart failure. They also have antioxidant, neuroprotective, and hepatoprotective properties [4, 5]. The wide range of physiological activity of triterpene glycosides opens up great prospects for their practical use as drugs [6-8].

Cyclosiversioside F - cycloartane glycoside isolated from 12 plant species of the genus Astragalus (Leguminosae). A.pterocephalus (0.93-1.45%), A.kuhitangi (1%), A.exilis (0.43), A.sieversianus (0.31%), A.schahrudensis (0.01%), A.villosissimus (0.22%) A.basineri (0.43%), A.tragacantha (0.50%), A.dis-

sectus (0.58%), A.pycnanthus (1.25%), A.uninodus (1.42%), A.leiosemius (1.20%).

Crushed air dried roots with stems (2.1 kg), prepared in 2016 in the Surkhandarya region of Uzbekistan, were exhaustively extracted with methanol (5 x 10 L). The purified extractants were chromatographed over a column of silica gel.

The column was first eluted with chloroform, then by a solvent system of chloroform-methanol (20:1). The elution of the column with this system yielded a compound (1) that was identified as β-sitosterol. Substance (2) was isolated with mp 239-2410C (from methanol) and identified as cyclosiversigenin [2, 3]. Glucopyranoside β-sitosterol and cyclosiversiosides A, C, and E were isolated with elution by a system of chloroform-methanol-water (70:12:1), then (70:23:4). Cyclosiversioside F was also isolated; it is the main compound of the sum of extractive substances in the amount of 1.45% [2, 3].

A study of the chemical composition of A.pterocephalus plants growing in various regions showed that the qualitative composition of the main glycoside cyclosiversisoside F is conserved.
The chemical structure of cyclosiversioside F contains aglucone-cyclosiversigenine and two sugar residues in the form of xylose and glucose.

Cyclosiversioside F - $C_4{}^1H_{68}O_{14}$. Spectrum data: NMR ^1H (300 MHZ, C^5D^5N, δ, ^2J/Hz): 0.17 and 0.60 (2H-19, d, 2J=3.6), 0.91, 1.27, 1.27, 1.34, 1.38, 1.56, 2.06 (7xCH_3, s), 2.50 (H-17, d, ^3J=7.5), 3.10 (H-22, k, $^2J=^3J1=3J^2$=10), 3.49 (H-3, dd, 3J1=11.5, 3J2=4), 4.82 (H-1 D-Xylp, d, ^3J=7.1), 4.87 (H-1 D-Glcp, d, ^3J=7.7), 4.96 (H-16,k, 3J1=3J2=3J3=7).

Chemical structure of Cyclosiversioside F with mp. 285-286 °C (from methanol) was identified with data of known Astragaloside IV [4].

Materials and Methods

The extraction of plants was carried out with two different solvents - ethyl [2] and methyl alcohols [3] at room temperature. The solvents were 96% ethanol and methanol, extracted five times, and the sum of extractive substances was recovered.

All cardiotonic activity studies used healthy animals quarantined for at least 10-14 days [9, 10].
Cardiotonic activity was studied in a model of chronic heart failure (CSN) caused by mesatone administration followed by dynamic exercise [11, 12]. Experiments were carried out on white non-fertile rats (both sexes) with body weight of 180-200 g., a total of 36 animals were used, with 6 animals per group.

500 mg Mildronate capsule drug for assessing cardiotonic activity, the preparation of the was used, Grindex JSC Latvia. Since this drug has a cardioprotective, antihypoxant, and metabolic effect and is used to treat chronic heart failure. ECG registration, followed by cardiac contraction rate determination, was performed with an electrocardiograph "VE-100," "EDANISNTRUMENTS, INC," China. The recording speed of the electrocardiogram was 25 mm/s. Equipment: The HPLC system consists of a DIONEX equipped with an UltiMate 3000 autosampler, an UltiMate 3000 pump, an UltiMate 3000 column compartment, an UltiMate 3000 variable wavelength detector.
Method: Compounds were chromatographed on a YMC-Pack ODS-A C18 column (250 x 4.6 mm, 5 µm - sorbent dispersion) at 30 ° C with an acetonitrile-water mobile phase (33:67, by volume) at a flow rate of 1.0 ml / min. Detection was performed at 205 nm.

Studies of biochemical parameters were carried out on a biochemical analyzer "HUMALYZER Primus" (semi-automatic), with a metrological characteristic: 340, 405, 500, 546, 620 nm reagent flow rate of 400 µl.

Pharmacological Properties: A 500 mg Mildronate capsule (active substance: 500 mg meldonium) is an agent for the correction of metabolic processes.

It is a drug that improves the metabolism and energy supply of tissues. Meldonium dihydrate is a synthetic analog of gamma-butyrobetaine, a substance that is located in each cell of the human body.

The mechanism of action determines the variety of its pharmacological effects: increased performance, reduced symptoms of mental and physical overstress, activation of tissue and humoral immunity, and cardioprotective action. It inhibits gamma-butyrobetaine hydrooxinase, reduces the synthesis of carnitine and the transport of long-chain fatty acids through cell membranes and prevents the accumulation of activated forms of non-oxidized fatty acids-derivatives of acylcarnitine and acyl coenzyme A. in the cells during ischemia, meldonium restores the equilibrium between oxygen delivery processes and the consumption of oxygen in cells, prevents disruption of ATP transport, and simultaneously activates glycolysis, which proceeds without additional oxygen consumption. As a result of the decrease in carnitine concentration, gamma-butyrobetaine with vasodilating properties is intensively synthesized.

It has a cardioprotective effect, and normalizes myocardial metabolism. In acute ischemic myocardial damage, meldonium slows down the formation of a necrotic zone and shortens the rehabilitation period. In heart failure, the drug increases myocardial contractility, increases exercise tolerance, and reduces the frequency of angina attacks.

In acute and chronic ischemic disorders of cerebral circulation, it improves blood circulation in the ischemia focus and promotes blood redistribution in favor of the ischemic site.

It is effective in the vascular and dystrophic pathology of the eye fundus.

It has a tonic effect on the central nervous system, and eliminates functional disorders of the somatic and autonomic nervous system in patients with chronic alcoholism who experience withdrawal syndrome.

Studies of Cardiotonic Activity of Cyclosiversioside F.
Animals of all groups (except intact) were injected intramuscularly (into the femoral muscle) with a 0.1% solution at a dose of 5 mg/kg (0.1 ml/200 g). Furthermore, one minute after the introduction of the mesatone, animals of all groups were placed in

a container with water at room temperature and forced to swim until exhausted for 4-5 minutes. Then, one hour after forced swimming (dynamic exercise), drugs were administered to the animals in the experimental groups once daily for 5 days in the following order:

1- intact group (control) - animals without test modeling;
2- control group (control) - animals with test modeling, but without exposure to drugs;
3- test group №1 - animals orally received Cyclosiversioside F as a 10% aqueous suspension, at a dose of 500 mg/kg, in a volume of 0.5 ml/100 g;
4- test group № 2 - animals orally received Cyclosiversisoside F as a 10% aqueous suspension, at a dose of 1000 mg/kg, in a volume of 1.0 ml/100 g;
5- test group № 3 – animals orally received Cyclosiversioside F as a 10% aqueous suspension, at a dose of 1500 mg/kg, in a volume of 1.5 ml/100 g;
6- Comparison group №1 - animals orally received "Mildronate" in the form of a 10% aqueous suspension, at a dose of 500 mg/kg, in a volume of 0.5 ml/100 g;
7- Comparison group №2 - animals orally received "Mildronate" in the form of a 10% aqueous suspension, at a dose of 1000 mg/kg, in a volume of 1.0 ml/100 g;
8- Comparison group №3 - animals orally received "Mildronate" in the form of a 10% aqueous suspension, at a dose of 1500 mg/kg, in a volume of 1.5 ml/100 g.

After the last administration of the substances, an ECG was taken for animals in the state of ether anesthesia, followed by the determination of the cardiac contraction rate (HR). Then, blood was taken from the cardiac region. The animals were then sacrificed by cornio-cervical dislocation and the breast cavity was opened to remove the heart. The heart was weighed on electronic weights to an accuracy of 0.001 g, and the relative weight of the organ was calculated.

The criteria for assessing pharmacological activity are as follows: normalization of the relative weight coefficient of the heart; normalization of heart rate (HR); normalization of serum biochemical indicators (ACT, lactodehydrogenase, MB creatine kinase, cholesterol, triglycerides, total protein, albumin, sodium, potassium, calcium, and magnesium).

The collected blood was placed in a serological tube (red cap) with no anticoagulant content. The serum for biochemical blood tests was obtained by centrifugation at 3000 rpm for 10 minutes.

Based on the obtained data on the effective doses of the test drug using the breakdown table, ED30, ED50 and ED100 were calculated.

The results were processed by the method of variation statistics according to student criteria at p = 0.05 [8, 9]. The tables show the mean arithmetic values (M), the corresponding standard error of the mean values (m), the student criteria (t), the number of samples (n), and the confidence intervals (lower confidence confidence limit).

Results

As a result of the simulation of chronic heart failure, an increase in the heart weight coefficient was observed (Table 1). However, in the case of Cyclosiversioside F administration at doses of 500 mg/kg (17.5%), 1000 mg/kg (25.0%) and 1500 mg/kg (20.9%), a decrease in heart weight was observed. This effect was the highest at a dose of 1000 mg/kg.

In the case of the administration of the comparison drug, at doses of 500 mg/kg (23.0%), 1000 mg/kg (25.3%), and 1500 mg/kg (21.5%), a decrease in the weight coefficient was also observed, with the highest effect observed at a dose of 1000 mg/kg.

When comparing the experimental data of the most effective doses of glycoside and the comparison drug, no difference between the two drugs was observed.

Table 1: Changes in Relative Heart Mass (M ±tm; p=0,05; n=6)

Name of group	Relative Heart Weight	% effect
Intact	0,39583 (0,35763÷0,43404)	-
Control	0,59883 (0,53267÷0,66500)	-
Cyclosiversioside F (500 mg/kg)	0,49383 (0,46033÷0,52734)	17,5%
Cyclosiversioside F (1000 mg/kg)	0,44900 (0,40240÷0,49560)	25,0%
Cyclosiversioside F (1500 mg/kg)	0,47383 (0,43920÷0,50847)	20,9%
«Mildronate» (500 mg/kg)	0,46083 (0,42052÷0,50115)	23,0%
«Mildronate» (1000 mg/kg)	0,44750 (0,39581÷0,49919)	25,3%
«Mildronate» (1500 mg/kg)	0,47033 (0,42274÷0,51793)	21,5%

When considering changes in Heart Rate, it was found that when modeling chronic heart failure (CSN), an increase in Heart Rate was observed (Table 2). When glycoside and Mildronate were administered, no significant changes were observed.

Table 2: Cardiotonic Activity Determined by Change in Cardiac Contraction Rate (M ± tm; p=0,05; n=6)

Name of group	Basic data	Data after modeling
Control	170,50 (163,21÷177,79)	196,33 (182,43÷210,24)
Cyclosiversioside F (500 mg/kg)	172,17 (165,29÷179,05)	198,33 (180,40÷216,26)
Cyclosiversioside F (1000 mg/kg)	173,67 (164,69÷182,64)	187,33 (167,06÷207,61)

Cyclosiversioside F (1500 mg/kg)	176,33 (166,77÷185,90)	188,33 (170,86÷205,80)
«Mildronate» (500 mg/kg)	177,33 (166,53÷188,13)	184,83 (167,62÷202,05)
«Mildronate» (1000 mg/kg)	175,50 (163,85÷187,15)	184,67 (161,44÷207,90)
«Mildronate» (1500 mg/kg)	171,33 (157,91÷184,75)	193,50 (175,78÷211,22)

When considering changes in the biochemical parameters of blood serum, it was found that when simulating CSN, there was a significant increase in lactodehydrogenase and creatine kinase MB, as well as a reliable decrease in sodium and potassium levels (Table 3). When the test preparation was administered at doses of 500 mg/kg, 1000 mg/kg, and 1500 mg/kg, there was a decrease in the level of lactodehydrogenase and creatine kinase MB, as well as an increase in sodium levels. The greatest normalization of lactodehydrogenase, creatine kinase MB, and sodium levels is observed at a dose of 500 mg/kg.

In the case of the comparative drug, a decrease in lactodehydrogenase and creatine kinase MB levels and an increase in sodium levels were also observed at doses of 500 mg/kg, 1000 mg/kg and 1500 mg/kg. The greatest normalization of the level of lactodehydrogenase, creatine kinase MB, and sodium was observed at a dose of 1500 mg/kg. It should also be noted that the normalization of sodium levels at a dose of 500 mg/kg was observed in a similar manner to the dose of 1500 mg/kg.

When comparing the experimental data of the most effective doses of the test drug and the comparison drug, it was found that the normalization levels of sodium lactodehydrogenase in both drugs were comparable. However, in the case of Creatine Kinase Isoenzyme MB, it can be seen that Cyclosiversioside F reduced the level of Creatine Kinase Isoenzyme MB more than the comparison drug.

Table 3. Blood Serum Biochemical Indicators (M±tm; p=0,05; n=6)

Type of analysis	Indicators (Unit)	Intact	Control	Cyclosiversioside F (500 mg/kg)	Cyclosiversioside F (1000 mg/kg)
Enzymes	Aspartate aminotransferase, (AST) U/ L	77,1667 (59,4430÷94,8904)	79,1667 (65,6786÷92,6548)	76,5000 (66,6027÷86,3973)	83,3333 (71,6193÷95,0474
	LDH (Lactat dehidrogenaza), U/L	724,6667 (602,8601÷846,4733)	1203,3333 (877,0365÷1529,6302)	437,3333 (301,2272÷573,4395)	624,8333 (405,1240÷844,5426)
	Creatine Kinase Isoenzyme (CK-MB) U/L	428,6667 (355,8376÷501,4957)	1200,8333 (965,8634÷1435,8033)	282,4833 (225,0873÷339,8794)	305,1667 (245,0012÷365,3321)
Lipids	Cholesterin (Chol), mmol/ L	0,7650 (0,5546÷0,9754)	0,8800 (0,5927÷1,1673)	0,7650 (0,6030÷0,9270)	0,8150 (0,6743÷0,9557)
	Triglycerides (Trig), mmol/ L	0,1283 (0,0570÷0,1996)	0,4233 (0,1747÷0,6720)	0,3900 (0,1490÷0,6310)	0,2533 (0,1443÷0,3624)
	Albumin (Alb), mmol/ L	35,3667 (32,7026÷38,0307)	32,9333 (30,6833÷35,1834)	32,2500 (30,0703÷34,4297)	33,3667 (32,0080÷34,7253)
Electrolytes	Sodium (Sodium), mmol/L	161,0000 (157,4149÷164,5851)	147,8333 (144,9009÷150,7658)	155,8333 (152,7782÷158,8884)	154,5500 (151,5691÷157,5309)
	Potassium, mmol/L	3,4433 (3,2388÷3,6478)	3,0050 (2,8446÷3,1654)	3,3383 (2,9632÷3,7134)	3,2500 (2,9734÷3,5266)
Minerals	Calcium (Calicium), µmol/L	2,5233 (1,8311÷3,2156)	2,4967 (2,4277÷2,5657)	2,4467 (2,3334÷2,5600)	2,3850 (2,2033÷2,5667)
	Magnesium (Magnium), µmol/ L	1,0733 (1,0087÷1,1379)	1,0367 (0,9663÷1,1070)	1,0783 (0,9717÷1,1849)	1,0400 (0,9395÷1,1405)

Continuation of the table 3: Blood Serum Biochemical Indicators (M ± tm; p=0,05; n=6)

Type of analysis	Indicators	Cyclosiversioside F (1500 mg/kg)	Mildronate (500 mg/kg)	Mildronate (1000 mg/kg)	Mildronate (1500 mg/kg)

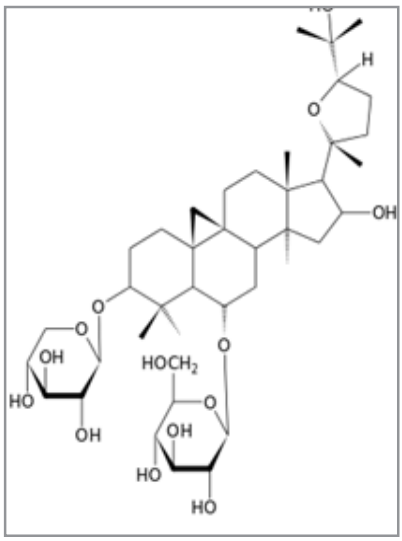
Enzymes	Aspartate ami-no-transferase (AST), U/L	69,1667 (54,4670÷ 83,8664)	64,8333 (53,2810÷ 76,3856)	81,3333 (62,7672÷ 99,8995)	69,8333 (58,9691÷ 80,6976)
	LDH (Lactat dehi-drogenaza), U/L	714,6667 (569,7150÷ 859,6184)	696,0000 (598,0186÷ 793,9814)	617,5000 (412,7274÷ 822,2726)	570,1667 (273,0135÷ 867,3199)
Lipids	Creatine Kinase Isoenzyme (MB), U/ L	0,8583 (0,7142÷1,0024)	0,8383 (0,7151÷ 0,9615)	0,8583 (0,6440÷ 1,0726)	0,8917 (0,7481÷ 1,0353)
	Triglycerides (Trig), mmol/L	0,4650 (0,0619÷0,8681)	0,1900 (0,0664÷ 0,3136)	0,1617 (0,0504÷ 0,2730)	0,5700 (0,1140÷ 1,0260)
Proteins	Total protein (TP), mmol/L	68,3833 (65,4731÷ 71,2936)	68,5667 (63,5601÷ 73,5732)	64,2333 (59,5410÷ 68,9256)	64,9333 (59,9078÷ 69,9589)
	Albumin (Alb), mmol/L	32,2167 (29,3235÷ 35,1099)	35,2667 (32,0528÷ 38,4805)	34,6000 (31,8396÷ 37,3604)	30,8833 (27,5381÷ 34,2286)
Electrolytes	Sodium (Sodium), mmol/L	154,2333 (151,5364÷ 156,9303)	159,3333 (153,4999÷ 165,1668)	158,0000 (152,1247÷ 163,8753)	159,3333 (154,2032÷ 164,4634)
	Potassium, mmol/L	3,2517 (3,0402÷3,4631)	3,2667 (3,0767÷ 3,4566)	3,3733 (3,0375÷ 3,7091)	3,3300 (3,1332÷ 3,5268)
Minerals	Calcium (Calcium), µmol/L	2,4083 (2,2443÷2,5723)	2,3917 (2,1039÷ 2,6795)	2,3833 (2,0922÷ 2,6745)	2,3700 (2,0379÷ 2,7021)
	Magnesium (Mag-nium), µmol/L	1,0883 (0,9472÷1,2295)	1,0800 (0,9788÷ 1,1812)	1,0833 (0,9937÷ 1,1729)	1,0617 (0,9810÷ 1,1424)

To calculate the ED30, ED50 and ED100 Cyclosiversioside F, experimental data of the change in the weight coefficient of the heart (the main evaluation criterion) at doses of 500 mg/kg and 1000 mg/kg was used. The results of the study were plotted on a breakdown table and it was graphically determined that ED30 = 400 mg/kg, ED50 = 445 mg/kg, and ED100 = 1000 mg/kg.

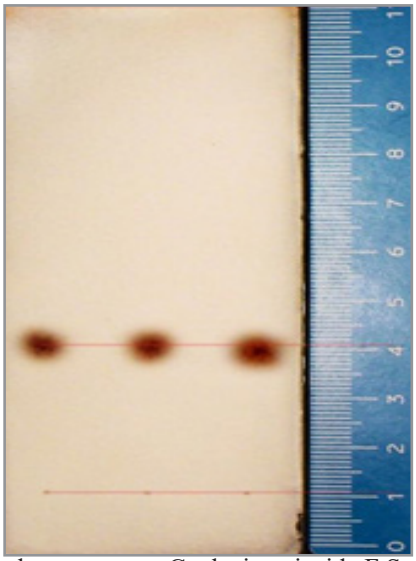
Discussions

Based on the obtained data, Cyclosiversioside F was revealed to have cardiotonic activity, which is manifested in the normalization of the heart weight coefficient and in the normalization of the biochemical parameters of blood serum (lactodehydrogenase, creatine kinase MB, and sodium). Moreover, a comparative study of the cardiotonic activity of Cyclosiversioside F with a reference cardiac metabolism showed that glycoside is not inferior to the reference drug in cardiotonic activity; in some cases, it even exceeds it namely, a greater decrease in the level of creatine kinase MB in mesatonic heart failure conditions indicates greater cardioprotective and anti-ischemic activity of Cyclosiversioside F.

The most effective dose was also determined - 1000 mg/kg. The obtained data on doses such as ED30 = 400 mg/kg, ED50 = 445 mg/kg, and ED100 = 1000 mg/kg can serve as the basis for calculating starting and subsequent doses for clinical studies.



Cyclosiversioside F
C41H68O14, M.m. 784



Thin layer chromatogram Cyclosiversioside F System: chloroform-methanol-water (70:23:4). Rf = 0.3

Conclusion

A cycloartane triterpenoid was isolated from the A.pterocephalus plant and the cardiotonic activity of Cyclosiversioside F compared to the drug Mildronate was studied. It was found that glycoside has cardioprotective and anti-ischemic activity not inferior and in some cases superior to the reference drug.

This study has been carried out with the hope that medicinal plants containing active components will contribute to the creation of new safe agents.

Acknowledgements

The work was carried out with the financial support of the Ministry of Innovation Development of the Republic of Uzbekistan (I-FA-2019-27). Studies of cardiotonic activity were carried out at the LLC Scientific Centre "MED STANDART" of Republic Uzbekistan by team of Ph.D Imamaliev B.A.

References

1. Korovin, E. P., Vvedenskii, A. V. (1955). Flora of Uzbek SSR. Tashkent: Academy of Sciences of the Uzbek SSR. 3, 684.
2. Agzamova, M. A., Isaev, M. I., Gorovits, M. B., Abubakirov, N. K. (1986). Triterpene glycosides of Astragalus and their genins. XIX. Cycloartane compounds and sterols from Astragalus pamirensis and A. pterocephalus. Chemistry of Natural Compounds, 22(1), 115-116. 3Agzamova, M. A., Isaev, I. M. (2016). Chemical components of Astragalus pterocephalus. Chemistry of Natural Compounds, 52(3), 501-502..
3. Kitagawa, I., Yoshikawa, M., Yoshihara, M., Hayashi, T., Taniyama, T. (1983). Saponin and sapogenol. XXXV. Chemical constituents of astragali radix, the root of Astragalus membranaceus Bunge. (2). Astragalosides I, II and IV, acetylastragaloside I and isoastragalosides I and II. Chemical and Pharmaceutical Bulletin, 31(2), 698-708
4. Khushbaktova, Z. A., Agzamova, M. A., Syrov, V. N., Mirsalikhova, N. M., Umarova, F. T., Isaev, M. I. (1994). Influence of cycloartanes of plants of the genus Astragalus and their synthetic analogs on the contractile function of the myocardium and the activity of Na,K-ATPase. Chemistry of Natural Compounds, 30(4), 510-514
5. Tsaruk, A. V., Khushbaktova, Z. A., Syrov, V. N., Agzamova, M. A., Kasimova, G. M. (2008). Pharmacocorrection of lipid metabolism disorders in rabbits with atherosclerosis with cyclosartane glycoside – cyclosiversioside F. Pharmaceutical Journal, (1), 72-78. [In Russian].
6. Tsaruk, A. V., Isaev, I. M., Agzamova, M. A., Vypova, N. L., Khushbaktova, Z. A., Syrov, V. N., Isaev, M. I. (2010). The study of the action of cyclosiversioside F on the blood coagulation system. Uzbek Biological Journal, (5), 10-12. [In Russian].
7. Tsaruk, A. V., Iskenderov, D. A., Agzamova, M. A., Khushbaktova, Z. A., Syrov, V. N., Isaev, M. I. (2010). Isolation and study of cycloartane glycosides of cycloorbicoside G and cyclosiversioside A on metabolic processes in the rat myocardium. Chemical and Pharmaceutical Journal, 44(1), 12-15. [In Russian].
8. Khabriev, R. U. (Ed.). (2005). Guidelines for the experimental (preclinical) study of new pharmacological substances. Moscow: OJSC "Medicine" Publishing House.
9. Mironov, A. N. (2012). Guidelines for preclinical drug research. Part one (944 pp.) Moscow: Grif K.
10. Stefanova, A. V. (2002). Preclinical studies of medicines (methodological recommendations) (568 pp.) Kiev: Avicena.
11. 12. Liskova, Yu. V., Salikova, S. P., Stadnikov, A. A. (2014). Experimental models of heart failure: The state of the question and the results of their own research. Morphological Statements, (1), 46-53.