UNIVERSUM: ХИМИЯ И БИОЛОГИЯ

Научный журнал
Издается ежемесячно с ноября 2013 года
Является печатной версией сетевого журнала
Universum: химия и биология

Выпуск: 7(85)

Июль 2021

Часть 2

Москва
2021

УДК 54+57
ББК 24+28
U55

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U55 Universum: химия и биология: научный журнал. – № 7(85). Часть 2.
М., Изд. «МЦНО», 2021. – 36 с. – Электрон. версия печ. публ. –
<http://7universum.com/ru/nature/archive/category/785>

ISSN : 2311-5459

DOI: 10.32743/UniChem.2021.85.7-2

Учредитель и издатель: ООО «МЦНО»

ББК 24+28

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Содержание	
Papers in english	4
Biological sciences	4
General biology	4
Zoology	4
DATA ON THE DISTRIBUTION AND ECOLOGY OF SANDSTONE LEPUS CAPENSIS IN BUKHARA REGION Avaz Rayimov Rashid Rakhmonov Hikoyat Nurova Moxinur Rustamova	4
ANALYSIS OF ACRIDOTHERES TRISTIS SPRING FOOD COMPOSITION Avaz Rayimov Mokhinur Rustamova	9
Physiology	14
ECONOMIC AND PHYSIOLOGICAL TRAITS OF PIMA COTTON LINES IN UZBEKISTAN AND THEIR CORRELATION Shavkiev Jaloliddin Shamsutdin ugli Saidigani Nabiev Abdulakhat Azimov Shukhrat Khamdullaev Bakhtiyar Amanov Khushnud Nurmetov	14
Chemistry sciences	22
Bioorganic chemistry	22
THE EXTRACTION AND FRACTIONATION OF FERULA SAMARCANDICA ROOT EXTRACTS Khamidulla Kamoldinov Sobithon Sobirov Murodullo ugli Akbarjon Nishonov Zulfiya Usmonova Tokxirjanovna Kuldosheva Sarvinoz Alimardon kizi	22
Inorganic chemistry	27
SYNTHESIS AND STRUCTURE OF MONO AND MIXED LIGAND COORDINATION COMPOUNDS OF SILVER WITH 2-AMINO-1-METYL BENZIMIZOLE Otabek Pardaev Dildora Khakimboeba Shahlo Daminova Zukhra Kadirova Khasan Sharipov	27

PAPERS IN ENGLISH

BIOLOGICAL SCIENCES

GENERAL BIOLOGY

ZOOLOGY

DATA ON THE DISTRIBUTION AND ECOLOGY OF SANDSTONE LEPUS CAPENSIS
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E-mail: mrustamova@mail.ru*СВЕДЕНИЯ О РАСПРОСТРАНЕНИИ И ЭКОЛОГИИ LEPUS CAPENSIS
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ABSTRACT

The article provides information on the ecology, number and characteristics of seasonal and territorial distribution of *Lepus capensis* in the desert zone of Bukhara region, environmental factors affecting it and the species' adaptation to these influences. These data were obtained on the basis of our observations in the south-western part of the Kyzylkum, such as Karakir, Zamonbobo, Dengizkul, Khadicha, Zikri, Devkhona, Qumsulton and Ayak Ogirma, as well as in the Kagan fishery for 2012-2020. The study of the dynamics of the number of *Lepus capensis* is of great importance in predicting the increase and decrease of its number.

АННОТАЦИЯ

Информация об экологии, численности и особенностях сезонного и территориального распространения *Lepus capensis* в пустынной зоне Бухарской области, экологических факторах, влияющих на нее, и адаптации этих воздействий Хадиджа, Зикри, Девхона, Кумсултон и Аякогитма, а также рыбохозяйственные районы Кагана на основе наших наблюдений за 2012-2020 годы. Изучение динамики численности *Lepus capensis* очень важно для прогнозирования увеличения и уменьшения их численности.

Keywords: *Lepus Capensis*, fox, hyena, owl, hawk, kovrak, mountain buckthorn.

Ключевые слова: *Lepus Capensis*, лисица, гиена, сова, ястреб, коврак, облепиха.

Introduction. Bukhara region is located in the south-west of Uzbekistan. Global environmental problems, in particular, anthropogenic factors, affect the environment, including the distribution and bioecological characteristics of mammals. In recent years, construction and construction of transport and railways, gas pipelines in these areas have also affected the biodiversity of the region. Dynamics of the number of *Lepus capensis* changes under the influence of biotic, abiotic and anthropogenic factors.

Materials and methods. A large part of the study area is composed of gypsum soils, rocks, sandy loam and sandy loam. wormwood *Artemisia* diffuse, heights *Anabasis eriopodava* we observed that it is coated with a similar ephemeral, as well as ephemeroids. The study area was surveyed a total of 48 times on land using stationary and route counting methods [2; 3; 4;].

$$D = \frac{n}{2 \cdot L \cdot W};$$

where D is the density; n is the number of birds encountered; L is the route length; W is the width of the route, or the distance from the route axis to the boundary of the calculated corridor. Multiplication 2 was used in the formula to account for the animals to the left and right of the route axis. [5; 6; 7].

Results analysis. Particular attention is paid to the management of the number of mammals, which are

widespread in the world, important in nature and in the national economy, through a comprehensive study and their use in the interests of man. In particular, the expansion of the type and scale of human economic activity and the increasing impact on the environment require ecological sustainability in urban areas and the conservation of mammalian diversity. is focused. Special attention is paid in our country to the protection of nature, conservation of biological diversity and rational use of biological resources. As far as we know, any change in biotopes is manifested primarily on the basis of known changes in the lives of representatives of flora and fauna in the biocenosis. Representatives of the mammalian world are also considered to be ecological "indicators" of changes in the environment through their actions. Humans sometimes sense and evaluate the effects of biotic or abiotic factors occurring in the environment through these indicators. However, from the 1950s to the 1960s, the unfavorable environmental situation began to have a negative impact on the sand dunes - *Lepus capensis*, as well as representatives of the entire animal kingdom. As a result, the sand dunes - *Lepus capensis* - left the area one after another for a short time. This situation requires a re-analysis of their distribution ecology in the republic. It should be noted that the same changes have led to changes in the south-western regions of the country, the ethological characteristics of the sandpiper - *Lepus capensis*, the state of distribution, the nature of the encounter.

Table 1.

Seasonal changes in the number of sand dunes (*Lepus capensis*) in the desert areas of Bukhara region ()

Seasons of the year	Korakir	Devkhona	Zikri	Khadicha	Zamonbobo	Dengizkul	Ogitma	Kumsulton	Total
Spring	10	2	17	6	3	37	7	13	95
Summer	16	4	23	14	5	35	11	15	123
Autumn	21	5	25	23	6	44	13	17	154
Winter	14	3	19	11	3	34	9	12	105
Total	61	14	84	54	17	150	40	57	477

Today, sandstorms are increasing in the desert areas of Bukhara region. In particular, during the corona virus pandemic that shook the world in 2020, we observed a positive shift in the number of species in nature in a short period of time by partially limiting the negative impact of humans on nature. At the same time, the number

of species increased compared to previous years due to unplanned hunting, poaching, and harvesting of plants as a result of human activities, with the exception of those traveling in the wild. This is definitely one of the positive things in nature.

Figure 1. Annual rate (number) of distribution of sand dunes (*Lepus capensis*) across desert areas

It was noted that the area, geographical location, ecological status and abundance of food resources, as well as the level of influence of anthropogenic factors play a decisive role. In this regard, the main part of the number of sand dunes is recorded in Dengizkul (31%) and Zikri (18%) and Karakir deserts (13%), which have the most favorable ecological potential. The relatively

low incidence of sand noise in the modern desert areas, the high level of anthropogenic impacts in these desert areas, the small area around Devkhana Lake and the poor vegetation cover show their effects. In nature, vegetation also plays an important role in influencing wild-life.

Figure 2. Seasonal dynamics of sand larvae (*Lepus capensis*) in the desert areas of Bukhara region

The analysis of our results shows that the highest number of sand dunes is observed in the deserts observed in summer and autumn. This indicator has been found to facilitate feeding, reproduction, and feeding in these deserts. The winter and spring seasons show a low number of sand dunes in the desert areas. It was found that this indicator is not conducive to feeding, reproduction in these deserts, as well as the fact that the hunting season in the autumn and winter months will lead to a partial reduction in the number of species. According to the data, in 1980-2000, in the desert zone bordering Alat, Karakul and Jondor districts, there were a lot of falcons, and in those days hunters hunted them mainly at night using the headlights of tractors and cars. At the same time, each hunter caught an average of 10 vultures per night. Now the natural landscape of these places has changed radically and the forests have disappeared. In the mentioned years, voles were hunted according to fixed terms, and voles were hunted not only as amateurs but also as industrial hunters. Its fur was received at special reception points and then processed. The sharp decline in the number of sandpipers and the abolition of their fur-bearing organizations has led to a decline in the importance of this species as a hunting object and interest in falconry. such as the harvesting of other plants as fuel and fodder, a sharp decrease in the sources of food and shelter for it due to the increase in the number of hooves, and other factors. In desert biocenoses, the increase in the number of foxes and chihuahuas, which are the natural enemies of sand dunes, leads to the intensification of "predator-type" biotic relationships, while the increase in livestock hooves in these areas leads to the emergence of trophic relations in the form of competition. Both situations are manifested in a decrease in the number of speakers. In May 2018, in the Khojam-Sayyod area of Karakul district, a baby boy was found killed in a nest of chickens. We also observed a pair of yellow

sorrels feeding on the sand dunes on October 20, 2020, around Lake Foot.

The life of the sandpiper, like other species that are hunted, is not directly related to water bodies. However, we have observed that the sparse vegetation of the desert zone is attracted by the sparsely covered reeds and sedges of these species along the lake shore. Given that this species lives mainly on lands belonging to the forest fund, it can be said that the solution of problems in the field of forest protection is important in the protection of sand dunes and the proper use of sand. From this point of view, it is expedient for forestry and hunting farms to coordinate their activities in the protection of sand dunes as a hunting object, to pay attention to the issues of afforestation and pasture rehabilitation.

Conclusion: It should be noted that the formation of artificial water basins in the desert zone is of great importance in the lives of sand dunes. In doing so, we found that some species may change their previous habitats in part depending on natural environmental conditions. However, there are a number of disadvantages in these watersheds that prevent these species from adapting to the region.

- In winter and especially in spring, shepherds set fire to dry reeds around lakes;
- Existence of unauthorized hunting by poachers;
- Lack of full control over the territory of the region;

The periodic change in the population of *Lepus capensis* is associated with the change of seasons. The rare change in the number of *Lepus capensis* populations occurs due to violations of habitat conditions (drought, cold winter season)

From this we can conclude that the formation of a fully adapted stable population of *Lepus capensis* in the observed desert biocenosis is still ongoing.

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ANALYSIS OF ACRIDOTHERES TRISTIS SPRING FOOD COMPOSITION

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АНАЛИЗ СОСТАВА ВЕСЕННЕГО КОРМА ОБЫКНОВЕННАЯ МАЙНА
(ACRIDOTHERES TRISTIS)

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ABSTRACT

The article provides an analysis of the spring-season feed spectrum of *Acridotheres tristis* and its diversity in terms of biotopes, as well as the issues of *Acridotheres tristis*'s participation in trophic relations. The nutrient content of a total of 81 mayonnaises was analyzed during the spring season (23 on March, 34 in April, and 24 in May). The total bodyweight of the brain, the total weight of the stomach, and the nutrient weights in the stomach tend to increase from March to May. The increase in total body weight was directly proportional to the increase in the number of nutrients in the stomach and its contents, with an average weight gain of 44.8% in May compared to March, 42.8% of stomach weight and 85% of stomach weight, respectively.

АННОТАЦИЯ

В статье представлен анализ весенне-сезонного кормового спектра *Acridotheres tristis* и его разнообразия с точки зрения биотопов, а также вопросы участия *Acridotheres tristis* в трофических отношениях. Содержание питательных веществ в общей сложности в 81 майонезе было проанализировано в течение весеннего сезона (23 марта, 34 апреля и 24 мая). Общий вес мозга, общий вес желудка и вес питательных веществ в желудке, как правило, увеличиваются с марта по май. Увеличение общей массы тела было прямо пропорционально увеличению количества питательных веществ в желудке и его содержимом, со средним увеличением веса на 44,8% в мае по сравнению с мартом, 42,8% веса желудка и 85% веса желудка, соответственно.

Keywords: insect, stomach, agrocenosis, plant, animal wheat, barley, corn, millet.

Ключевые слова: насекомое, желудок, агроценоз, растение, животное пшеница, ячмень, кукуруза, просо.

Introduction: Materials for studying the nutritional spectrum of *Acridotheres tristis* In the spring of 2010-2020 in Bukhara and Karakul oases Peshko, Konimex, Kyzyltepa Dengizkul, Mubarek district, Karavulbozor, Karakir lake, Gazli, Zafarabad, Ayoqogitma, biotopes (settlements, water, agrots from the coastal zone of the basins and pastures).

Materials and methods: G.A Novikov, 1953, and Malchevsky, 1976 methods were used to determine the nutrient content of the brain [1; 2; 5; 6; 7]. It used 16-calibre hunting rifles, GAMO air rifles and synthetic

fishing nets. Stomachs isolated from adult brains were stored in the laboratory with fixation to 5% formalin. Data on the total weight of the stomach, the amount and type of nutrients in them were studied in the Laboratory of Human and Animal Physiology of Bukhara State University. Appropriate identifiers were used to identify insects and other nutrients in the feed [3; 4].

Result and Discussion: Along with their nutritional composition, total body and stomach masses were also studied (Table 1). The total bodyweight of the brain, the total weight of the stomach, and the nutrient weights in

the stomach tend to increase from March to May. The increase in total body weight was directly proportional to the increase in the number of nutrients in the stomach

and its contents, with an average weight gain of 44.8% in May compared to March, 42.8% of stomach weight and 85% of stomach weight, respectively.

Table 1.

In the spring, the body weight, stomach and nutrient weight of the brain (n = 81)

Months	Weight(g)			Weigh of the stomach (g)			Nutrition weigh (g)		
	min	max	middle	min	max	middle	min	max	middle
March (n=23)	81	107	95,3±0,1 Cv% 9,1	3,0	6,2	4,9±0,17 Cv%0,85	1,8	5,0	2,7±0,36 Cv%0,96
April (n=34)	94	121	109,7±0,06 Cv% 6,67	3,7	8,0	5,7±0,2 Cv%1,11	2,5	5,7	4,3±0,22 Cv%0,93
May (n=24)	105	153	138±0,11 Cv% 15,18	4,9	9,0	7,0±0,17 Cv%1,16	3,5	5,5	5,0±0,08 Cv%0,41

The total bodyweight of the brain, the total weight of the stomach, and the nutrient weights in the stomach tend to increase from March to May. The increase in total body weight was directly proportional to the increase in the amount of nutrients in the stomach and its contents, with an average weight gain of 44.8% in May compared to March, 42.8% of stomach weight and 85% of stomach weight, respectively.

Information on the frequency of occurrence of nutrients in the stomachs of different agroecosystems, shores of water basins and pastures caught in the meadows, the amount of occurrence in each stomach of the feed type, the total amount of nutrients in the studied stomachs are given in Tables 2-3. A total of 59 lizards from different agroecosystems (cotton, winter wheat, alfalfa, private plots of the population) were caught and the nutrient content in the stomach was studied (Table 2).

Table 2.

Nutritional composition of mites (n = 59) hunted from agroecosystems in spring

T/p	Type of nutrition	Frequency of nutrition in stomach		Variation	Total weight of nutrition	
		Absolute	%		Absolute	%
	Nutrition of plant (seeds)					
1	Triticum	6	10,1	1-4	16	1,35
2	Hordeum vulgare	1	1,69	2	2	0.16
3	Zea mays	2	3,38	1-3	4	0.33
4	Vigna radiata	1	1,69	3	3	0,25
5	Morus nigra	9	15,25	2-7	37	3,12
6	Morus alba	12	20,33	1-9	58	4,89
7	Morus multicaulis	7	11,86	4-10	42	3,53
8	Panicum miliaceum	4	6,77	3-5	15	1,26
9	Echinochloa crus-galli	3	5	3-6	12	1,01
11	Avena sativa	8	13,55	2-8	43	3,63
12	Convolvulus arvensis	2	3,38	2-4	6	0,50
	All				238	20.8
Nutrition of animal						
13	Lumbricus terrestris	9	15,25	1-3	15	1,26
14	Lymnaeatruncatula	4	6,77	1-2	4	0.33
15	Porcellio	7	11,86	1-5	23	1,94
16	Araneus diadematus	2	3,38	2	4	0,33
17	Ephemera vulgata	3	5	4-9	19	1,60
18	Melolontha afflicto	2	3,38	1	2	0,16
19	Melolontha hippocostani	1	1,69	1	1	0,08

T/p	Type of nutrition	Frequency of nutrition in stomach		Variation	Total weight of nutrition	
		Absolute	%		Absolute	%
20	<i>Lasius niger</i>	5	8,47	6-12	43	3,62
21	<i>Culex pipiens</i>	4	6,77	2-7	19	1,60
22	<i>Chyllotalpa gryllotalpa</i>	10	16,94	1	10	0,84
23	<i>Desticus verrucivorus</i>	16	27,11	1-2	21	1,77
24	<i>Lestesdrays</i>	7	11,86	1-2	10	0,84
25	<i>Musca domestica</i>	4	6,77	1-8	16	1,35
26	<i>Blatta orientalis</i>	2	3,38	1-2	3	0,25
27	<i>Anthonomus pomorum</i>	7	11,86	2-4	19	1,60
28	<i>Scantiusaegyptius</i>	9	15,25	2-7	37	3,12
29	<i>Chlorideaobsolete</i>	5	8,47	2-5	16	1,35
30	<i>Collas erate</i>	4	6,77	1-3	7	0,59
31	<i>Chrysomela populi</i>	11	18,64	3-9	66	5,56
32	<i>Eupygaster integriceps</i>	23	38,98	5-9	161	13,58
33	<i>Ephilachnachsomelina</i>	2	3,38	1	2	0,16
34	<i>Tabanus bovinus</i>	6	10,1	1-4	13	1,09
35	<i>Aphis medicaginis</i>	13	22	9-15	156	13,16
36	<i>Mabitis religiosa</i>	3	5	1	3	0,25
37	<i>Bercaea haemorrhoidalis</i>	9	15,25	1-4	26	2,19
38	<i>Acanthosoma haemorrhoidale</i>	14	23,72	3-7	77	6,49
39	<i>Pieris brassicae</i>	3	5	1	3	0,25
40	<i>Anacanthotermes turkestanicus</i>	4	4,9	1-3	9	0,73
41	<i>Synapsistmolus</i>	2	3,38	1	2	0,16
42	<i>Curculionidae</i>	1	1,69	1	1	0,08
43	<i>Leucochloe daplidicae</i>	3	5	1	3	0,25
44	<i>Cetonia aurata</i>	2	3,38	1	2	0,16
45	<i>Locusta migratoria</i>	7	11,86	1-2	10	0,84
46	<i>Thisoetrus adspersus</i>	4	6,77	1-4	11	0,92
47	<i>Solifugae</i>	1	1,69	1	1	0,08
48	<i>Capricornis fuscispinus</i>	6	10,1	1-3	12	1,01
49	<i>Cicadatra guerua</i>	2	2,4	2	4	0,33
50	<i>Ixodes ricinus</i>	3	5	1	3	0,25
51	<i>Phytonomus variabilis</i>	12	20,33	5-11	76	6,41
52	<i>Pisces</i>	5	8,47	1-3	10	0,84
53	<i>Rana ridibunda</i>	2	3,38	2-4	6	0,50
54	<i>Bufo viridis</i>	5	8,47	1-6	19	1,60
55	<i>Lacerta agilis</i>	2	3,38	1	2	0,16
	All				947	79.9

In the studied stomachs, the occurrence of body parts of plants and animals belonging to 55 species was detected. Of these, 43 animal species (including larvae) (78%) and 12 plant species (22%). Balkh smoke from plant foods has the highest rate of occurrence (12, 20.33%) and total number (58, 4.89%). The incidence and the total number of harmful insects from animal food species were found to be high (23, 38.98% and 161,

13.58%, respectively). In the spring, 22 mines were caught to study the nutrient content from the shores of water bodies and pastures (Table 3). Only animal feed belonging to 26 species was found in their stomachs. In terms of frequency of encounters, locusts (13, 59.0%), black ants (77, 16.27%) were found to be the leaders in terms of the total number of feeders.

Table 3.

The nutritional content of nipples (n = 22) hunted on the banks of water basins and pastures in spring

T/p	Type of nutrition	Frequency of nutrition in stomach		Variation	Total weight of nutrition	
		Absolute	%		Absolute	%
1	Blatta orientalis	3	13,6	1-5	10	2,11
2	Ixodes ricinus	7	31,8	4-12	51	10,78
3	Tubefex tubefex	4	18,1	2-5	14	2,95
4	Lumnala trunkatula	4	18,1	1-2	6	1,26
5	Porcellio	10	45,4	3-7	49	10,35
6	Asellus aquaticus	3	13,6	1-3	7	1,47
7	Araneus diadematus	4	18,1	1-2	6	1,26
8	Culex pipilns	7	31,8	1-4	20	4,22
9	Synopsis tmolus sols	3	13,6	1	3	0,63
10	Leucochloe daplidicae	5	22,7	1	5	1,05
11	Cetonia aurata	4	18,1	1-2	6	1,26
12	Mabtis religiosa	6	27,2	1	6	1,26
13	Anacanthotermes turkestanicus	5	22,7	2-6	21	4,43
14	Nepa cinerea	4	18,1	1-2	6	1,26
15	Musca domestica	6	27,2	1-4	15	3,17
16	Bercaea haemorrhoidatis	9	40,9	2-6	36	7,61
17	Lasius niger	11	50,0	4-10	77	16,27
18	Tabanus bovinus	9	40,9	2-6	36	7,61
19	Lestes drays	11	50,0	1-3	22	4,65
20	Locusta migratoria	13	59,0	1-2	19	4,01
21	Thisosetrus adspersus	8	36,3	1-3	16	3,38
22	Solifugae	1	4,5	1	1	0,21
23	Capricorns fuscispinus	5	22,5	1-3	10	2,11
24	Chyllotalpa gryllotalpa	7	31,8	1-2	10	2,11
25	Rana ridibuda	5	22,5	1-3	9	1,90
26	Pisces	4	18,1	1-4	12	2,53
	All				473	100

The nutrients found in the stomachs of lizards in the spring (Table 3) are of 59 species, which can be divided into 2 groups. The diversity of animal feeds is large in terms of quantity (1420 objects), accounting for 85.6%

of the total feed. Mines also feed on seeds of various plants in the spring. Their content in the feed (238 objects) is 14.4% of the total feed (Figure 1).

Figure 1. Distribution of nutrients in groups in the spring

A large number of types and amounts of animal-specific nutrients have been observed in the diet, which can be explained by the fact that during the breeding season the brain feeds relatively much with insects, the fruits they feed on are not ripe, and so on. By studying the composition of the stomach and observing its nutrition, it was determined that in the spring months, the lizards feed on 4 species of vertebrates (fish fry, frog and frog larvae, lizard body parts). In particular, in May 2011 in Karakul district was found a lizard that was half-eaten from 4 nests of lizards. In June 2014, fish fry in the pond was observed to feed on frogs and frog larvae in May 2013 and May 2017, respectively. In May 2014, it was discovered that the chicks were feeding the chicks with frog larvae.

It should be noted that the frequency of occurrence of grain products (wheat, barley, corn, millet, etc.) in the

stomachs of mines hunted from the villages is relatively high, and this situation is observed in all seasons of the year. This can be explained by the fact that lizards feed on mixed fodder given to livestock and poultry and have direct trophic contact with them. The nutrient spectrum of the brain is very wide, characterized by seasonal variability of nutrient composition, in which there is an abundance of products of anthropogenic origin. The uneven distribution of insects, which form the basis of food, indifferent agrocenoses is also reflected in the complication of trophic relationships.

Conclusion: It can be said that in the spring, the lizards feed on agrocenoses, pests that damage agricultural and fodder crops on the banks of water bodies and pastures, participate in the biological control of pests. The brain is a useful species for recorded biocenoses.

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PHYSIOLOGY

DOI: 10.32743/UniChem.2021.85.7

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Uzbekistan, Tashkent region, Chirchik city, Amir Temur***Corresponding author email: jaloliddinshavkiev1992@gmail.com*ЭКОНОМИЧЕСКИЕ И ФИЗИОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ
ХЛОПЧАТНИК ЛИНИИ PIMA В УЗБЕКИСТАНЕ И ИХ КОРРЕЛЯЦИЯ**Шавқиев Жалолиддин Шамсутдинович***науч. сотр. лаборатории экологической генетики и физиологии растений,
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ABSTRACT

In the article, the morpho-physiological indicators in the thin fibrous lines of cotton belonging to *G. barbadense* L. type, total water content in plant leaves, water retention properties of leaves, transpiration intensity, specific leaf density, third leaf dry weight and third leaf level indicators and morphological-economic traits have the results of the analysis of plant productivity, productivity up to October 10, cotton weight per boll, fiber yield, fiber index and weight of 1000 seeds. Pima cotton lines and standard Surkhon-14 variety differed from each other by physiological indicators of water exchange of plant – total water content in the leaves, transpiration rate and leaf water retention. Morphological-economic and physiological indicators of fine fiber cotton lines were evaluated comparatively. T-2006, T-10, T-1 and T-5445 - boll weight, T-167 and T-663 fast ripening, T-167, T-2006 and T-5440 - productivity, T- 5440 and T-5445 - fiber yield, T-10, T-167, T-5440 and T-5445 - fiber index, T-10, T-1 and T-2006 are valuable in terms of 1000 seed weight characteristics have been identified as primary selection item and was recommended for use as a primary source.

АННОТАЦИЯ

В статье рассмотрены морфофизиологические показатели тонких волокнистых линий хлопчатника, относящиеся к типу *G. barbadense* L., общее содержание воды в листьях растений, водоудерживающие свойства листьев, интенсивность транспирации, удельная плотность листьев, сухая масса третьего листа и третьего уровня листа и морфолого-экономические признаки имеют результаты анализа урожайности растений, урожайность до октября, веса коробочки, урожая волокна, индекса волокна и массы 1000 семян. Линии хлопчатника Pima и стандартный сорт Сурхон-14 отличались друг от друга по физиологическим показателям водообмена растений - общему содержанию воды в листьях, скорости транспирации и влагоудержанию листьев. Проведена сравнительная оценка морфолого-экономических и физиологических показателей линий тонковолокнистого хлопчатника. T-2006, T-10, T-1 и T-5445 - масса коробочки, T-167 и T-663 быстросозревающие, T-167, T-2006 и T-5440 - урожайность, T-5440 и T-5445 - выход волокна, T-10, T-167, T-5440 и T-5445 - индекс волокна, T-10, T-1 и T-2006 ценны с точки зрения весовых характеристик 1000 семян, были определены как первичный элемент выбора и рекомендован к использованию в качестве первоисточника.

Keywords: *G. barbadense* L., cotton, line, physiology, productivity.

Ключевые слова: *G. barbadense* L., хлопчатник, линия, физиология, урожайность.

Introduction

Cotton plant is an important technical crop that provides raw materials for the textile, food, chemical, paper and other industries. In the world market, the fiber of *G. barbadense* L. type cotton varieties is very valuable and is valued at 1.5-2 times and more than the fiber of Upland cotton varieties. From 1 ton of this type of fiber, 1.3-2.0 times more fabric is woven than the fiber of Upland cotton varieties, and its cost is 3-4 times more expensive [5].

In the decree of the President of the Republic of Uzbekistan, Sh.M. Mirziyoyev on February 7, 2017 under number PD-4947 “About strategy of actions on further

development of the Republic of Uzbekistan”, the tasks for creation and introduction of new selection of varieties of agricultural crops resistant to diseases and pests, adapted to local soil-climatic and ecological conditions have been set for implementation. Cabinet of Ministers of RUz on January 30, 2020 adopted a resolution № 47 “About effective organization of cultivation of fine-fiber cotton, stimulation of the mechanism of reproduction and introduction of new varieties”. These decrees and resolutions show that our president and government pay great attention to the further development of cotton growing, in particular, to the further expansion of the area under Pima cotton.

At present, one of the urgent tasks of today is to create new varieties of Pima cotton, suitable for the region of Uzbekistan, which are precocious, high-yielding, high-fiber, resistant to adverse environmental factors. Therefore, it is important to study the relationship of morphological-economic traits to the physiological traits of Pima cotton plants.

It is known that the quantitative characteristics of cotton mainly include valuable economic characteristics – precocity, productivity, fiber length, yield, tensile strength and fineness, boll weight and other characteristics. The main product of cotton is fiber, which is evaluated according to its quality. *G.barbadense* L. cotton is the youngest and most plastic species, its first homeland is South America [1,13].

Worldwide, *G.barbadense* L. type accounts for 9% of the total cotton area. Mainly grown on the islands and plains of the United States, it became known as Sea Island. Later, Sea Island cotton varieties entered the Nile valleys of Egypt and were grown in large areas as long staple Egyptian cotton varieties [4,15].

The countries with the highest yields of cotton fiber in the world are the United States, Egypt, Israel, Australia and Uzbekistan, and the countries with the lowest yields are Asia, Africa, Oceania, Europe and South America [14]. Today, Uzbekistan produces more than 1 million tons of cotton fiber, and ranks the fifth place in the world and is the second largest seller after the United States [16].

The Republic of Uzbekistan is one of the countries in the world that has mastered the cultivation of Pima cotton. The main reason for this is the heat in the wide areas of southern regions of the country, particularly the heat in Sherabad are higher than in Cairo (Egypt), and in Termez higher than in Alexandria (Egypt) and Bayram Ali (Turkmenistan) and also allows for the effective work of advanced breeders and seed scientists of the country [8]. To date, in cotton-growing countries, including our country, the area under cotton has been reduced, taking into account changes in market demand and other conditions. In 1987, Pima cotton varieties were planted on 204,000 hectares of land in the country, and the total yield was 587,000 tons. Our country is the second largest producer of these cotton varieties in the world after Egypt [8]. Given the high value of the products of Pima cotton varieties on the world market, it is necessary to create and introduce such varieties in our country.

Due to the shortage of fine fiber in the world, the United States has increased the area under the finest fiber Pima cotton varieties (*G.barbadense* L.) from 80,000 to 110,000 hectares. In addition to its own fine-fiber varieties, India purchases an additional 150,000 tons of Pima fiber [8].

Although Pima cotton varieties account for 3% of world cotton production, they are commercial varieties that provide high quality fiber [4,6]. Pima varieties are mainly grown in the fields of Egypt, the western, northwestern United States, and some provinces of China[7]. In 2012, 94% of Pima varieties grown in the USA were grown in the San Joaquin Valley, California, and the remainder in Arizona, New Mexico, and Texas [4,7].

During the years of independence of Uzbekistan, the number of textile enterprises processing fiber of long-staple varieties, the production of high-quality finished fabrics and durable yarns for domestic and foreign markets has increased [3].

The main goal of world cotton selection programs is to increase cotton yields and improve fiber quality[2,3]. Pima cotton varieties are highly demanding to high heat temperatures in terms of biological characteristics and are grown in small areas in the southern regions of the country [5].

In Uzbekistan, Pima cotton varieties have been planted in small areas due to their late maturity, low yields and small sized bolls. The creation of Pima cotton varieties that fully meet the needs of domestic and foreign markets and provide good quality fiber with world requirements and the expansion of the area of Pima cotton in our country will greatly benefit the economy of our country. This raises the issue of improving the productivity and early ripening of *G. barbadense* L. type cotton varieties [5]. Pima cotton varieties are very resistant to verticillium wilt disease, which is the main disease of Upland cotton varieties [1].

According to Sh. Akmuradov, there is no correlation between plant height and the main valuable economic characteristics, including the weight, fiber yield and length of cotton in a single boll[1].

Nabiev (2019) et al., noted that the lower and compact the height of the cotton plant is, the greater the number of seedlings, the better the level of flowering and ripening, and the weak and moderate correlation of cotton ripening with the plant height trait [11].

As Uzbekistan is the northernmost cotton-growing country, one of the main tasks is here to study the precocity of cotton. Also, early-maturing cotton varieties are essential not only for the northern regions, but also in hot regions for early and high-quality harvesting in a short period of time without the onset of adverse weather conditions.

According to Kimsanbaev (2009), the precocity of cotton, like in all seed plants, is determined by the time it takes for the seed to awaken from viability to formation of mature seed and the opening of the first boll in the bush under sequenced phases and development stages. In this case, it is necessary to take into account the intensity of successive opening of the bolls in the bush, as well as the total yield before the onset of frost.

The number of fully ripened bolls and the weight of cotton in the bolls play an important role in the formation of high productivity in Pima cotton varieties [7,9,12].

Breeding scientists working with fine-fiber cotton have a task to create precocious cotton varieties that can produce the first-second type fiber of good quality, high yield, with large bolls, a fiber yield of 34% and more in the main cotton growing areas, resistant to fusarium wilt, root rot and macrosporiosis. It should be noted that the creation of such varieties will allow to grow not only in the southern regions of the country, but also in the middle regions, and will bring great economic benefits to cotton farms.

The aim of the study was to investigate the physiological and morphological-economic characteristics

of the local cotton lines of the fine-fiber *G. barbadense* L. species and to determine their correlation level.

Research objects and methods

As an object of the study, new lines T-167, T-663, T-2006, T-5440, T-5445, T-450 belonging to fine-fiber *G. barbadense* L. species created by the scientists of Research Institute of Genetics and Plant Experimental Biology of AS of RUz, and also T-1ва T-10 lines obtained from fine-fiber ruderal subspecies *ssp. vitifolium* through crossbreeding, standard Surkhon-14 variety were used.

Our research was conducted in 2019-2020 in the field of the experimental base Zangiota, located in Zangiota district of Tashkent region, belonging to the Institute of Genetics and Experimental Biology of the Academy of Sciences of the Republic of Uzbekistan. This area is located 1 km from Tashkent, in the upper reaches of the Chirchik River, at an altitude of 398 meters above sea level. The climate is characterized by strong heat in summer (June, July, August) and a sharp drop in temperature in winter (especially in December and January). Sunny days are 175-185 days, the period without frost makes 200-210 days. Precipitation is observed in autumn, winter and spring, and in summer the air is dry, which requires watering the cotton. The soil of the experimental field is a typical gray soil with low humus and moderate sandy by mechanical content. The slope of the land is weak, unsalted, weakly damaged by wilt. Groundwater is deep (8.0 meters and more). Soil moisture capacity is 22%, bulk density - 1.32-1.33 g / cm³. During the experiment of dissertation work irrigation was carried out in the scheme 1-2-1 in the growing season and the total volume of water was 4800 -5000 m³ / ha in the experimental field. This allowed the soil moisture to be kept at an acceptable level, i.e. 70% -72% relative to the limited field moisture capacity (LFMC). The farming technical measures applied in the year of the experiment allowed to ensure good growth and development of plants.

In our experiment, a 90x20x1 sowing scheme was used. Seeds were planted at a depth of 4 cm. Mineral fertilizers were applied by feeding three times during the growing season at the generally accepted norm, i.e. the total annual norm was N-250 kg / ha, P₂O₅-180 kg / ha, K₂O -115 kg / ha. The first feeding with fertilizers was carried out at the beginning of budding, the second at mass budding, the third one was at flowering stages. Inter-row processing/softening and weed control were carried out in conjunction with irrigation. Chemicals against thrips and aphids were used during the growing season of the plants.

To determine the physiological parameters of water exchange of plants of fine-fiber cotton lines, the 3rd leaf at the main stem from the growth point of 10 typical plants on each line was used. The total water content in the leaves was determined by the method of N.N. Tretyakov et al. (1990), the water retention property of the leaves by Kushnirenko M.D. et al (1970) method, transpiration intensity by Ivanov A.A. (1950) method.

During the experiment, the morphological traits of lines and the standard variety were determined by generally accepted methods. Valuable economic traits of cotton were identified by conducting phenological observations and recording on cotton yield per plant, number of bolls, weight of cotton in a single boll, biological precocity (time of opening of the first boll in the plant up to 50%), plant height, fiber yield, index, length, weight of 1000 seeds and using the generally accepted methods in the laboratory (UzCGRI, 2007).

The figures obtained for each trait were statistically processed by the variance analysis method to prove whether the difference between the lines and varieties was reliable or unreliable using the ANOVA method by the Fisher criterion, and the smallest difference ($P < 0.05$ and $P < 0.01$) was determined at 95% reliability. Correlation coefficients between the traits were also determined using the Statview program (SAS Institute Inc., Cary, NC, USA).

Research results and their analysis

Analysis of morphological-physiological traits of Pima cotton. Physiological indicators of water exchange were determined during the flowering-harvesting of plants in a special experimental area in the Zangi area of the Institute.

According to the results obtained, the total water content in the plant leaves ranged from 77.8% (T-2006) to 79.43% (T-5440) in fine-fiber varieties and lines (Table 1). The indicators total water content of fine-fiber lines and Surkhan-14 variety were close to each other. The leaf water retention (LWR) of the plants is the lowest in the T-10 line which spent 21.10% of the total water content in the leaves on evaporation in 2 hours, while the highest rate was noted in the T-450 line and Surkhan-14 variety, their 28.56. % and 29.30% water content relatively were found to have been spent on evaporation. Transpiration intensity was highest in the Surkhan-14 variety at optimal water regime in which fresh leaf made 263.3 mg H₂O/1 gram in 1 hour, while the lowest indication was in the T-10 and T-2006 lines with 149.04 mg and 156.56 mg H₂O/1 gram in 1 hour, respectively (Table 1).

Table 1.

Indicators of total water content, water retention properties and transpiration intensity in the leaves of Pima cotton lines and varieties

№	Cotton varieties and lines	Total leaf water content, %	Leaf water retention, %	Transpiration intensity, mg H ₂ O/1g fresh leaf x 1 hour
1.	T-167	78,53±0,44	27,50±1,15	245,3±9,0
2.	T-663	79,33±0,06	27,1±0,23	192,1±3,7
3.	T-2006	77,83±0,41	25,76±0,26	156,6±3,5
4.	T-5440	79,43±0,08	24,53±0,80	200,2±2,2
5.	T-10	79,33±0,26	21,10±1,23	149,0±0,3
6.	T-1	78,96±0,51	27,8±1,10	224,1±0,5
7.	T-5445	79,03±0,20	23,73±0,66	181,3±2,3
8.	T-450	79,30±0,05	28,56±1,08	230,3±0,5
9.	Surkhon-14	78,23±0,26	29,30±0,85	263,3±4,0

The specific leaf area density (SLAD), i.e., leaf thickness was highest in T-663 and Surkhon-14 variety, 61.15 mg and 60.72 mg / 10 cm², respectively, and lowest in the T-5445 line, 49.68 mg. The above-mentioned physiological parameters of water exchange were determined, the dry mass of the 3rd leaf from the growth point of the plant was the highest in the T-10 and

T-2006 lines, which made 937.3 mg and 909.0 mg, respectively, the lowest rate was noted in the T-5445 line, at 573.5 mg, respectively. The 3rd leaf area index was the highest in the T-1, T-2006, and T-10 lines (162.6 cm²; 158.3 cm² and 157.9 cm², respectively), while in the T-5440 line it was the smallest, at 108.8 cm² (Table 2).

Table 2.

Leaf area density, dry mass of the 3rd leaf and surface parameters of the 3rd leaf in Pima cotton varieties and lines

№	cotton varieties and lines	SLAD, mg/10 cm ²	dry mass of the 3 rd leaf, mg	Surface of the 3 rd leaf, cm ²
1	T-167	54,35±0,84	652,7±2,2	122,5±0,6
2	T-663	61,15±0,01	806,5±2,3	129,1±1,6
3	T-2006	57,75±0,85	909,0±1,2	158,3±1,4
4	T-5440	54,35±0,84	683,3±6,6	108,7±1,1
5	T-10	56,47±1,12	937,3±8,1	157,9±3,2
6	T-1	54,77±0,73	826,7±1,3	162,6±1,1
7	T-5445	49,68±0,73	573,5±2,0	113,1±1,0
8	T-450	53,50±1,46	719,8±2,8	135,6±2,4
9	Surkhon-14	60,72±0,42	733,0±0,5	124,9±1,4

Analysis of morphological-economic traits of Pima cotton

When the trait of the weight of cotton in a single boll of fine-fiber cotton lines was studied, it was found that the highest value was in the T-1 line (Table 3).

The weight of cotton in one boll in the standard variety Surkhon-14 was 4.0 grams. The lines T-1, T-663, T-450, T-5440, T-10 were statistically differentiated by bigger size of the bolls relative to this variety, and their index of the trait of cotton weight per boll was 4.9; 4.8; 4.7; 4.4 g and 4.4 g, respectively. Hence, these lines can be used as a primary material in selection work aimed at increasing the boll size of fine-fiber cotton. The remaining lines did not differ statistically from Surkhon-14 variety by this trait.

In the Pima cotton lines, the yield as of October 10, i.e., the cotton yield per plant per period, was determined.

The results obtained are presented in Table 7. According to the results, the cotton yield until October 10, i.e the weight of cotton per plant in the standard variety Surkhon-14 was 44.2 g, while in the lines the highest rate of this trait were recorded in the lines T-2006 and T-5440, 41.9 g and 40.5 g respectively (Table 7).

In terms of total productivity, the highest result was noted in the T-2006, T-450 and T-663 lines (64.9 g; 60.5 g and 58.7 g, respectively), and the lowest result was recorded in the T-167 line (48.3 g). The average rate on total productivity in the standard Surkhon-14 variety was 56.6 g per plant (Table 3). By total productivity, the T-2006, T-663 and T-450 lines had higher results than the standard variety. By October 10, the productivity was the lowest in the standard Surkhon-14 variety. The weight of cotton in one boll was higher in the lines than in the standard Surkhon-14 variety.

Table 3.

Parameters of valuable economic traits of Pima cotton lines

№	Lines and varieties	Cotton weight in one boll (g)			Productivity as of October 10, g/plant			Total productivity, g/plant		
		X	σ	V, %	X	σ	V, %	X	σ	V, %
1.	T-450	4,7	0,1	1,9	36,2	6,2	10,1	60,5	6,7	12,1
2.	T-5445	4,1	0,3	5,1	38,2	6,0	13,7	51,8	9,6	15,7
3.	T-663	4,8	0,2	3,7	36,9	5,1	10,8	58,7	10,7	11,8
4.	T-1	4,9	0,4	6,9	37,6	6,7	14,2	53,6	6,5	17,8
5.	T-10	4,4	0,4	8,7	36,4	4,0	11,0	51,7	9,0	13,3
6.	T-5440	4,4	0,2	3,0	40,5	4,3	10,6	56,8	11,2	14,2
7.	T-2006	4,1	0,3	3,7	41,9	3,4	8,1	64,9	15,6	12,4
8.	T-167	4,1	0,2	1,8	38,0	4,2	10,9	48,3	9,1	14,5
9.	Surkhon-14	4,0	0,2	4,9	44,2	3,6	8,1	56,6	5,7	10,1

Table 8 shows the indicators of traits on fiber yield, index and weight of 1000 seeds in Pima cotton lines and standard Surkhon-14 variety.

Analysis of the results showed that the highest rate of fiber yield was in the standard variety Surkhon-14 (36.7%). In all other lines except T-2006, fiber yield was over 34%. In the lines T-5445 and T-5440 the fiber yield was 36,4% and 35,9% respectively, in T-10 and T-1 35,6% and 35,1% respectively, in T-167, T-450 and T-663 34,9%, 34,3% and 34,1% respectively. So, the

lines of our experiment can correspond today's requirements. Fiber index rate was the highest in the line T-10, 7,5 g, while in the remaining genotypes it was 6,3-7,2 g.

The highest results on the weight of 1000 seeds which is one of important valuable economic traits, were noted in T-10 and T-2006 lines (136,8 g and 135,8 g respectively), the lowest rate was in Surkhon-14 variety and T-167 line (111,4 g and 117,0 g respectively).

Table 4.

Parameters of valuable economic traits of Pima cotton lines

№	Lines	Fiber yield, %			Fiber index, g			Weight of 1000 seeds, g		
		X	Σ	V, %	X	σ	V, %	X	σ	V, %
1	T-450	34,3	0,8	2,3	6,5	0,3	3,2	129,1	3,8	3,0
2	T-5445	36,4	0,6	1,5	7,1	0,1	0,9	124,0	3,0	2,4
3	T-663	34,1	1,0	3,0	6,6	0,2	2,6	127,9	3,5	2,7
4	T-1	35,1	0,9	2,7	7,1	0,1	2,0	131,6	4,0	3,1
5	T-10	35,6	0,7	1,9	7,6	0,3	4,1	136,8	5,1	3,7
6	T-5440	35,9	0,7	1,9	7,1	0,1	1,6	128,0	4,1	3,3
7	T-2006	33,7	1,0	2,9	7,2	0,3	4,7	135,8	4,3	3,3
8	T-167	34,9	1,5	3,3	6,3	0,3	3,1	117,0	8,4	3,2
9	Surkhon-14	36,7	0,8	2,0	6,5	0,3	4,0	111,4	3,2	2,9

The leaf water retention had a strong positive correlation (0.83) with the transpiration rate, while with the fiber index and the weight of 1000 seeds it had a strong negative correlation (-0.80 and -0.86, respectively). It was found that there was a strong negative correlation (-0.64 and -0.71, respectively) between transpiration intensity and the fiber index, the weight of 1000 seeds. There was a strong positive correlation (0.74) between the specific leaf area density and the fiber yield. Dry mass of the 3rd leaf had a strong positive correlation (0.86) with the surface of the 3rd leaf. It was also found that there was a strong negative correlation (-0.64) between the weight of cotton in one boll and the yield as of October 10. A strong positive correlation (0.74) was noted between the fiber index and the weight of 1000 seeds (Table 5).

Transpiration intensity and water retention from physiological traits had a negative correlation with morphological traits, fiber index and weight of 1000 seeds. Experience has shown that when the transpiration rate and water retention are high, the fiber index and the weight of 1000 seeds are low, or vice versa, when the transpiration rate and water retention are low, the fiber index and the weight of 1000 seeds are high.

When Avtonomov et al studied the correlation between fiber yield and fiber index in fine-fiber cotton, it was found that there was a reliable positive strong and moderate correlation, with a correlation index from 0.40 to 0.85[4]. Vik.A. Avtonomov et al (2009) found that there was no significant correlation between fiber yield and 1000 seed weight, fiber index, yield, and boll weight.

Conclusion

Pima cotton lines and standard Surkhon-14 variety differed from each other by physiological indicators of water exchange of plant – total water content in the leaves, transpiration rate and leaf water retention.

Morphological-economic and physiological indicators of fine fiber cotton lines were evaluated comparatively. Tested lines were found to be valuable primary breeding materials by their traits: T-2006, T-10, T-1 and T-5445 lines by cotton weight in a single boll, T-167 and T-663 lines by their precocity, T-167, T-2006 and T-5440 lines by total yield, T-5440 and T-5445 lines

by fiber yield, T-10, T-167, T-5440 and T-5445 lines by fiber index, T-10, T-1 and T-2006 lines by the weight of 1000 seeds and they were recommended to use as primary source.

Transpiration intensity and water retention characteristics from physiological traits had a negative correlation with morphological traits, fiber index and weight of 1000 seeds.

Acknowledgements

The authors are grateful to the Zangi-Ata Experimental Field Station for providing space and resources to carry out this work.

Table 9.

Correlation between morphological-economic traits and physiological traits of fine-fiber cotton lines

	1	2	3	4	5	6	7	8	9	10	11	12
1		-0.34	-0.15	-0.29	-0.15	-0.23	-0.19	-0.19	-0.51	0.18	0.54	0.30
2			0.83**	0.32	-0.22	-0.08	-0.29	0.37	-0.09	0.33	-0.80**	-0.86*
3				0.09	-0.50	-0.35	-0.28	0.45	0.01	0.33	-0.64*	-0.71*
4					0.56	0.24	-0.14	0.06	-0.39	0.74*	-0.11	-0.52
5						0.86*	0.16	-0.36	-0.44	0.36	0.26	0.05
6							0.08	-0.24	-0.23	0.16	0.15	0.08
7								-0.64*	0.13	-0.41	0.04	0.47
8									0.33	0.34	-0.09	-0.45
9										-0.54	0.01	0.35
10											0.13	-0.52
11												0.74*

Difference in precision level: $P < 0,01$ ** and $P < 0,05$ *

1-total water content of leaves, 2-leaf water retention, 3-transpiration intensity, 4- specific surface area density, 5-dry mass of the 3rd leaf, 6-surface of the 3rd leaf, 7-cotton weight in one boll, 8-productivity by October 10, 9- total productivity, 10- fiber yield, 11- fiber index, 12-weight of 1000 seeds

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CHEMISTRY SCIENCES

BIOORGANIC CHEMISTRY

THE EXTRACTION AND FRACTIONATION OF FERULA SAMARCANDICA ROOT EXTRACTS

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Republic of Uzbekistan, Namangan*ИЗВЛЕЧЕНИЕ И ФРАКЦИОНИРОВАНИЕ ЭКСТРАКТОВ КОРНЯ
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ABSTRACT

This article presents high-quality and modern world-class methods for the fractionation of FERULA SAMARCANDICA root extract. Hexane, chloroform, butanol, ethyl acetate fractions were divided into successful fractions. Sesquiterpene compounds, coumarin glycosides were first synthesized from the root part.

АННОТАЦИЯ

В данной статье представлены качественные и современные методы мирового уровня для фракционирования экстракта корня FERULA SAMARCANDICA. Фракции гексана, хлороформа, бутанола, этилацетата были разделены на успешные фракции. Секвотерпеновые соединения, гликозиды кумарина впервые были синтезированы из корневой части.

Keywords: coumarins, flavonoids, phenols, terpenoids, steroids, extracts, aromas, hydrochloric acid, phytochemical, cancer.

Ключевые слова: кумарины, флавоноиды, фенолы, терпеноиды, стероиды, экстракты, ароматы, соляная кислота, фитохимия, рак.

Intradaction

Plants have been a constant source of drugs and considerable recent emphasis has been placed on finding novel therapeutic agents from medicinal plants. Many people prefer to use medicinal plants rather than chemical drugs. The *Ferula* genus from the family of Umbelliferae is a large genus of about 130 species distributed throughout the Mediterranean area and Central Asia [1]. Several species of this genus have been used in folk medicines [2], and investigations on the *Ferula* species have indicated antinociceptive, anti-inflammatory and antipyretic effects [3], contraceptive action [4,5], and smooth muscle relaxant activity [6,8]. This genus is well documented as a good source of biologically active compounds such as sesquiterpene coumarins [9] and sesquiterpene [10]. The *Ferula* genus has been found to be a rich source of gum resin [1]. The gum resins, which are obtained by incising the roots of several species, are used as spices and drugs in many countries.

Research methods and Experimental part.

The roots of *Ferula samarcandica* (family *Apiaceae*) were collected in September 2018 from Surkhandarya region, Republic of Uzbekistan. The methods used in the process of investigation on the qualitative analysis as well as separation include thin layer chromatography (TLC), silica gel column chromatography (silica gel: 200-300 mesh, Qingdao Marine Chemical Company, China), sephadex LH-20 column chromatography (LH-20 gel: Amersham Pharmacia Biotech, Sweden), and HPLC with a ODS-A (50 μ m) column produced by YMC Co.Ltd (Japan). The fractions were monitored by TLC, and spots were visualized by heating Silica gel plates sprayed with $AlCl_3$ in EtOH, ammonia vapor, 5% H_2SO_4 in EtOH with heating 105°C (Table 15). Ultraviolet absorption spectra were measured by an UV spectrophotometer (UV-2550 Shimadzu, Japan). 1H NMR, ^{13}C NMR, and 2D NMR spectra were recorded on Varian MR-400, VNMR-600 NMR spectrometers with TMS as an internal standard.

Table 1.

Chromatography for extraction and fraction of *Ferula samarcandica*

Column chromatography		TLC	
Petroleum ether: Acetone	8:1; 5:1; 3:1; 1:1	$CDCl_3$:MeOH:H ₂ O	65:35:5
$CHCl_3$:MeOH	20:1; 15:1; 9:1; 4:1	Hexan:EtOAc	4:1; 2:1
Hexan:EtOAc	10:1; 8:1; 4:1; 2:1	$CHCl_3$:MeOH	9:1; 4:1

Extraction and fractionation of *Ferula samarcandica* root extracts The roots of *F. samarcandica* (2 kg) was extracted at room temperature by EtOH (95%, 4×12 L), with 5 times duration of extraction (each 24 h). The crude extract suspended with water (1:1) and fraction-

ated successfully with petroleum ether (19.0 g), chloroform (16.0 g), ethyl acetate (32.0 g) and *n*-butanol (20.0 g). The sesquiterpene compounds, especially sesquiterpene coumarins were detected from the aqueous extract by two-dimensional paper chromatography in system solvents (*n*-hexane: EtOAc 4:1-2:1, $CHCl_3$: MeOH 9:1).

Sesquiterpenes and sesquiterpene coumarin glycosides were detected, using developed TLC plates, examined under UV at 254 nm and after spraying cerium sulfate as developer

The *n*-BuOH fraction of *F. samarcandica* (20 g) was subjected to HPD-300 macroporous adsorption resin (3:2, 7:3, 4:1, 19:1) to yield 6 fractions (Fsb-1-Fsb-6). Similarly fractions (Fsb-3, Fsb-5) were further subjected to an opening ODS A-120 CC, eluted with a gradient solvents MeOH-H₂O and MeOH (10-90% and 100-0%) to afford five subfractions. All sub-fractions

were analyzed by TLC and similar fractions were combined. Fraction Fso-4 and Fso-5 were investigated on Sephadex LH-20 with MeOH-H₂O as a eluent to yield compounds Fsp **21** (15 mg), **23** (50.4 mg) and subfraction of three compounds. Based on TLC analysis, subfractions were selected for HPLC analysis. The *n*-butanol fraction and all obtained subfractions were analyzed by HPLC using an optimized acetonitrile-water, ranging from 20% acetonitrile to 100% in 60 min at a flow rate of 1 mL/min. Samples were prepared in a concentration range from 1–10 mg/mL in methanol.

Figure 1. Structures of compounds isolated from the roots of *F. samarcandica*

The isolation of pure compounds was performed by semi-preparative HPLC (45-70; 25-45%), yielding compounds **24** (11.5 mg), **25** (14.8 mg), **26** (17.2 mg), **27** (17.5 mg), **28** (13 mg) and **29** (18 mg), **30** (17.5 mg), **31** (14 mg), **32** (11 mg) **33** (8 mg) and Phytochemical screening of ethanolic extracts of three medicinal plants was carried out using various chemical assay (such as TLC, HPLC, GC-MS) in order to identify either the presence or absence of secondary metabolites such as alkaloids, coumarins, phenolic compounds, flavonoids, glycosides, quinones, tannins, steroids and triterpenoids. The presence of coumarins, secoiridoids, and phenylethanoids is a characteristic feature of *Fraxinus species*. The secoiridoids occur mainly in the form of glucosides and esters of hydroxyphenylethyl alcohols. Lignans,

flavonoids and simple phenolic compounds are also common, but they appear to have more limited distribution. The occurrence of coumarins distinguishes the genus *Fraxinus* from the other genera in Oleaceae. *Effects of extraction solvent*: To find the optimal and effective solvent for the extraction process, various solvents were tested as shown in **Figure 2. Extraction with 70% to 90% ethanol, preferably from**: 60% to 90%, and most preferably: 70%. Yielded extract of 10g (60%), 13.7g (70%), 12.2g (80%), 10g (90%) from 100 g of dried *Fraxinus syriaca* plant. In our experiments, 70% ethanol was used due to the highest yield of extraction and the less toxicity of ethanol compared to the other solvents tested in this study (Fig 1).

Results and Discussions. Compound Fs-22 was obtained as an amorphous, white solid and its empirical formula was determined as $C_{24}H_{30}O_6$ by HR-ESI-MS (m/z 449.17355 $[M+Na]^+$, calcd 449.17000). The ^{13}C NMR spectrum of Fs-22 displayed 24 carbon signals, with nine being typical of an umbelliferone skeleton and ascribable to a sesquiterpene moiety (Table 16). The 1H NMR spectrum of Fs-22 showed signals due to five aromatic protons at δ_H 6.28 (1H, d, $J = 9.6$ Hz, H-3), 7.91 (1H, d, $J = 9.6$ Hz, H-4), 7.56 (1H, d, $J = 8.6$ Hz, H-5), 7.01 (1H, dd ($J = 8.6$; 2.4 Hz, H-6), and 7.07 (1H, d, $J = 2.4$ Hz, H-8), typical of an umbelliferone moiety. The sesquiterpene moiety showed four sharp singlet signals, at δ_H 1.22 (3H, s, H-12'), 1.09 (3H, s, H-13'), 1.22 (3H, s, H-14'), 1.03 (3H, s, H-15') and an oxygenated methylene group at δ_H 4.52 (1H, dd, $J = 10.4$; 1.6 Hz, H-11'axi) and 4.29 (1H, dd, $J = 10.4$; 6.4 Hz, H-11'eq). The HSQC experiment allowed the identification of 10 methines, of which five, at δ_C 113.2 (C-3), 145.7 (C-4), 130.3 (C-5),

114.3 (C-6), 102.4 (C-8) were characteristic for the umbelliferone unit, and three, at δ_C 78.8 (C-3'), 65.9 (C-5'), and 61.1 (C-9'), were attributable to the sesquiterpene moiety. Further HSQC correlations were indicative of two aliphatic methylenes at δ_C 39.7 (C-1'), 27.3 (C-2'), 61.1 (C-7'), an oxygenated methylene at δ_C 66.8 (C-11'), characteristic for C-11' usually involved in the linkage with the coumarin moiety, and four methyls at δ_C 25.4 (C-12'), 28.0 (C-13'), 15.8 (C-14') and 17.7 (C-15'). The HMBC correlations between the proton signal at δ_H 1.22 (Me-12') and the carbon resonance at δ_C 2.45 (C-7') and between the protons at δ_H 4.52 and 4.29 attributed to H₂-11' with the same carbon C-9' revealed the location of a tertiary methyl group (Me-12') at C-8. The correlation of Me-12' with the quaternary carbon at δ 75.6 allowed the occurrence of a tertiary alcoholic function to be deduced at C-8'. A further HMBC correlation between the singlet methyl at δ_H 1.03 (Me-15') and the carbon resonances at δ_C 39.7 (C-1'), 41.2 (C-10'), and 61.0 (C-9') revealed that the singlet methyl should be placed at C-10'.

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INORGANIC CHEMISTRY

DOI - 10.32743/UniChem.2021.85.7.12055

SYNTHESIS AND STRUCTURE OF MONO AND MIXED LIGAND COORDINATION
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СОЕДИНЕНИЙ СЕРЕБРА С 2-АМИНО-1-МЕТИЛБЕНЗИМИЗОЛОМ**Пардаев Отабек Тохтамышович***докторант кафедры «Неорганическая химия»
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ABSTRACT

For the first time, conditions were developed for the synthesis of mono- and mixed ligands coordination compounds of silver containing 2-amino-1-methylbenzimidazole as the main ligand, and its ligand complex compounds in the mixture with diisopropylthiophosphate acid, benzhydroxamic acid, diethyldithiocarbamates. The structure and coordination modes of ligand molecules in new mixed-ligand complexes have been established on the basis of a set of spectroscopic data and elemental analysis, and the features of thermal behavior have been revealed, which depend on the nature of complexing agents and ligands.

АННОТАЦИЯ

Впервые разработаны условия для синтеза моно- и смешаннолигандных комплексных соединений серебра, содержащих 2-амино-1-метилбензимидазол в качестве основного лиганда, и его лигандных комплексных соединений в смеси с диизопропилдитиофосфатной кислотой, бензгидроксамовой кислотой, диэтилдитиокарбаматами. Установлены строение и способы координации молекул лигандов в новых смешаннолигандных комплексах на основании совокупности спектроскопических данных и элементного анализа, выявлены особенности термического поведения, которые зависят от природы комплексообразователей и лигандов.

Keywords: silver, ligand, complex, 2-aminobenzimidazole, IR spectroscopy, element analysis, thermogravimetric analysis, quantum chemical calculation.

Ключевые слова: серебро, лиганд, комплексное соединение, 2-аминобензимидазол, ИК-спектроскопия, элементный анализ, термогравиметрический анализ, квантово-химический расчет.

Introduction. The rapid development of coordination chemistry is directly related to the study of the role of metal complexes in vital processes. The study of the action mechanism of physiologically active substances on biological membranes, enzymes, etc. is one of the current issues [1-2]. Particular attention is paid to complexes containing heterocyclic compounds containing the nitrogen atom from different classes of biologically active coordination compounds as ligands. In this regard, metal complexes based on benzimidazole derivatives are promising, they play an important role in biological processes, as well as, used as pharmacological agents and effective plant protection products [3-5].

Although the coordination compounds of intermediate metals with aminobenzimidazole derivatives have been considered in many studies [6-9], at the beginning of our study there were no data on mixed ligand coordination compounds of silver containing benzimidazole derivatives. Mixed ligand complexes with 2-aminobenzimidazole as the main ligand and diisopropylthiophosphate acid, benzhydroxamic acid, diethyldithiocarbamate as the additional ligands around the central atom have not been synthesized, and the reasons for the competitive coordination of the ligands have not been shown. Also coordination compounds of metals with $R_2RS_2^-$ ions have interest for analytical chemistry, such complex compounds are used in industry as accelerators to vulcanization processes, as well as, additives to oils and

motor fuels [10,11]. Mixed ligand complex compounds of metals with heterocyclic benzimidazole molecule and $R_2RS_2^-$ ions, contained N coordination atoms, may exhibit specific biological activity. In this regard, the study of the structure and properties of biologically active complexes of silver with benzimidazole is an urgent problem.

The aim of the work are to synthesize new coordination compounds of mono- and mixed ligands of silver ion with benzimidazole as the main ligand, to study their structure and properties by determination of relationships between composition, structure, properties.

Methods and materials. Chemically pure silver nitrate, benzhydroxamic acid (BGK), sodium diethyldithiocarbamate (DEDTK), potassium diisopropylthiophosphate (DiPDTF), 96% ethanol were used. The N-heterocyclic ligand 1-amino-2-methylbenzimidazole (MAB) was synthesized according to the methodology described in the literature [12]. FTIR, element analysis, powder X-ray diffraction (PXRD), differential-thermal analysis (DTA), scanning electron microscopy with energy-dispersion analysis (SEM-EDX) methods were used as research methods.

A LabX XRD-6100 diffractometer with CuK α radiation (Shimadzu, Japan) was used to determine the individuality of the synthesized complex compounds.

To study the complex formation of metals with organic ligands by FTIR spectrometer IRTracer-100 (Shimadzu, Japan), spectra were recorded in the wavelength range of 400-4000 cm^{-1} in KBr tablets.

Thermal analysis was performed by the STA 2500 Regulus DTA analyser, Netzsch (Germany) at a speed of 9 °/min and a sample weight of up to 50 mg at T-1000, TG sensitivity.

Microstructure analysis was performed on a Zeiss EVO MA 10 electron microscope (Carl Zeiss, Germany) with an EDS energy dispersive analysis attachment.

The structures of the main ligand MAB and the additional ligands is as follows:

MAB

BGK

DEDTK

DiPDTF

Synthesis of mono- and mixed-ligand complex compounds

[Ag(MAB)₂NO₃]. 0.294 g (0.002 mol) MAB was dissolved in 10 ml of ethanol with following addition the 10 ml of aqueous solution of 0.170 g of AgNO₃. The next day the white precipitate was filtered under vacuum, washed with cold ethanol, and air-dried. Yield 87%.

[Ag(MAB)₂(DiPDTF)]. 0.26 g (0.001 mol) of DiPDTF in 10 ml of ethanol was added at stirring to 0.170 g (0.001 mol) AgNO₃. The resulting white precipitate was filtered, washed in water and ethanol. Then dried precipitate dissolved in boiling alcohol, and 0.294 g (0.002 mol) of MAB in 10 ml of ethanol was added dropwise while stirring. The next day, the precipitate formed at the bottom of the vessel was filtered and washed with water and alcohol, and dried at room temperature, recrystallized in boiling alcohol, and filtered again. White needle-shaped crystals were formed. Yield 88%

[Ag(MAB)₂(BGK)]. 0.274 g (0.002 mol) of BGK in ethanol solution was mixed with 0.170 g (0.001 mol) of AgNO₃. The reaction mixture was magnetic stirred at room temperature for one hour. A 0.294 g (0.002 mol) solution of MAB in 10 ml of ethanol was then added dropwise while stirring. The mixture was heated in a

water bath for one hour. After cooling, it was filtered and washed in water and alcohol. The dried white precipitate was re-filtered in boiling absolute alcohol. White needle-shaped crystals were formed. Yield 78%

[Ag(MAB)₂(DEDTK)]. 0.170 g (0.001 mol) of AgNO₃ was mixed with 0.71 g (0.001 mol) of DEDTK in 10 ml of water. The reaction mixture was magnetic stirred at room temperature for one hour. A 0.294 g (0.002 mol) solution of MAB in 10 ml of ethanol was then added dropwise while stirring. The mixture was heated in a water bath for one hour. After cooling, it was filtered and washed in water and alcohol. The dried cream-colored precipitate was re-crystallized in boiling absolute alcohol. Yield 85%.

The scheme of synthesis of mono- and mixed-ligand silver complex compounds obtained as follows:

The elemental analysis of the synthesized complex compounds is presented in Table 1.

Table 1.

Results of elemental analysis of synthesized silver complexes

Compound	Element content, % (calculated / found)					
	M	C	H	P	N	S
[Ag(MAB) ₂ NO ₃]	23.27/23.08	41.37/41.58	5.41/5.36	-	21.12/20.77	-
[Ag((MAB) ₂ (BGK)]	20.1/19.95	51.2/53.11	4.64/4.42	-	18.18/17.48	-
[Ag((MAB) ₂ DEDTK)]	19.63/19.45	45.81/45.65	5.09/4.97	-	17.81/17.62	11.63/11.48
[Ag((MAB) ₂ DiPDTF)]	17.56/17.35	42.92/42.89	10.69/10.62	5.04/5.01	6.8/6.55	10.40/10.32

All synthesized complex compounds are insoluble in water, low in alcohol, well soluble in benzene, acetone, ether, carbon tetrachloride, chloroform.

Results and Discussion. The scanning SEM-EDX is now widely used to determine of the nitrogen, sulfur and metal amounts in the prepared complex compounds

(Figure 1). The silver peaks is clearly seen due to complex formation between the organic ligands and metal ions. The microstructure of the ligands was changed.

The elemental analysis of the obtained complexes was also confirmed by the results of X-ray fluorescence analysis (Fig. 2).

Электронное изображение 24

Figure 1. Microstructure of $[Ag (MAB)_2(DiPDTF)]$ complex compound (a) and SEM-EDX data (b)

Figure 2. EDX result of the $[Ag (MAB)_2(DiPDTF)]$

XRD of the synthesized complexes shows that samples do not contain impurities of the original products (Fig. 3). The presence of many XRD intense peaks indicates the complex crystalline structure of the complexes. It was found that XRD patterns, plane d-

spacing and line intensity of metal complexes differed from the corresponding ligands. This indicates that the synthesized complex compounds have a separate individual crystal lattice.

Figure 3. XRD of the $[Ag(MAB)_2(DEDTK)]$ complex compound

The FTIR spectra of mono- and mixed-ligand complex compounds of silver and MAB were obtained and analyzed to determine the properties of the ligands coordination centers to the central atom. For comparison, the IR spectra of the MAB, DiPDTF, Dtz, DEDTK organic ligands were analyzed. The FTIR spectra of complex compounds are shown in Figures 4-5.

Symmetrical (ν_s) and asymmetric (ν_{as}) valence vibrations of the ν_{NH_2} group are observed in the IR spectrum of the primary MAB ligand in the 3452–3200 cm^{-1} region. The deformation vibrations of δ_{NH_2} give insignificant intensity in the range of 1615–1655 cm^{-1} for the *exo*-amino group, and *endo*-amino group shows bands in the range of 1546 cm^{-1} . The wide band in the 3087–3034 cm^{-1} region belongs to the valence vibrations of the ν_{CH} group, and bands in the 1595–1540 cm^{-1} range belong to the $\nu_{C=N}$ groups of the heteroaromatic system [13].

The FTIR spectra of the DiPDTF ligand and its complex compounds are presented in the works [14–17]. The FTIR spectra of the DiPDTF ligand have a number of intense vibration lines. It can include the vibration bands of the P-O-R and P-O groups. The bands in the range 2960–2869 cm^{-1} refer to asymmetric and symmetrical vibration of the CH_3 -group. The asymmetric and symmetrical deformation vibrations of the δ_{CH_3} group include bands in the region of 1470–1347 cm^{-1} . The vibrations of the P-O-R group correspond to the bands in the area of 1178–1106, 1025–975, 940–810 cm^{-1} . The valence vibrations of the ν_{P-O} group include lines at 790–740 cm^{-1} . The presence of asymmetric lines with a maximum of 684–640 cm^{-1} is related to the P=S group vibrations. The lines in the area of 590–500 cm^{-1} belong to the P-S- vibrations. The P-S-bonds are equivalent, and the negative charge is distributed between the sulfur

atoms. During the transition from ligands to complexes, a low-frequency shift of the $\nu_{P=S}$ and ν_{P-S} lines is observed, it proves the formation of a metal-sulfur covalent bond. IR-spectroscopic study data of mixed ligand silver complexes show the bond formation between MAB and DiPDTF molecules. In this case, the shift of the vibrations lines of the C=N, N-H and P=S, P-S- R=S groups, as well as, the expansion and disintegration of the it's spectral signals. In the FTIR spectrum of $[Ag(MAB)_2(DiPDTF)]$ mixed ligand complexes, it was observed that the vibration frequency (680 cm^{-1}) of the $\nu_{P=S}$ group shifted to a lower frequency of 35 cm^{-1} than same $\nu_{P=S}$ frequency of the original DiPDTF molecule. The changes in the ν_{P-S} -region, shift of the the ν_{P-S} - group bands to a higher frequency of 23 cm^{-1} were observed. This confirms that this group is involved in coordination. New lines appear in the spectrum of the $[Ag(MAB)_2(DiPDTF)]$ mixed-ligand silver complex at 3452–3309 cm^{-1} (δ_{NH}), 1650–1660 cm^{-1} ($\nu_{C=N}$), 1546 cm^{-1} ($\nu_{C=N}$), it proves that silver binds DiPDTF heterocyclic and molecules.

Based on the FTIR spectrum of a mixed ligand complex silver compound with MAB and BGK, the effect of benzohydroxamic acid ($C_6H_5-C(O)NHOH$) containing amine group in the acidic hydroxamate fragment can be determined. characteristic frequencies of valence vibrations of the C=O and NH groups of the BGK molecule were observed in the FTIR spectrum [18]. During the complex formation process, the characteristic frequencies of C=O shifted to the lower frequency field, indicating the formation of a complex between the metal and the BGK. The shift of the C=O frequencies in the metal complexes is very large (27 cm^{-1}), which indicates the formation of a strong complex compound.

Figure 4. FTIR of the $[Ag(MAB)_2(DiPDTF)]$ complex compound

Figure 5. FTIR of the $[Ag(MAB)_2(BGK)]$ complex compound

Differential thermal analysis was performed to determine the thermal stability and composition of the obtained complex compounds (Figure 6). For example, the derivatogram of the $[Ag(MAB)_2(DiPDTF)]$ complex consists from 3 curves. Analysis of the differential thermogravimetric analysis curve (DTGA) (curve 2) shows two intensive decomposition temperature ranges. The decomposition temperature of $[Ag(MAB)_2(DiPDTF)]$

is 163.45 °C. First decomposition range corresponds to a 164–307 °C, and second decomposition range corresponds to 425–940 °C. The most intensive decomposition process takes place in the first decomposition interval. During this interval, the 56.3% of the sample was decomposed. The main mass loss occurs in the range of 150–930 °C with 90.2% of the mass loss.

Figure 6. DTA of the $[Ag(MAB)_2(DiPDTF)]$ complex compound

The decomposition temperature of the $[Ag(MAB)_2(BGK)]$ complex compound is 158.41 °C. First decomposition range corresponds to 152-317 °C with an intensive decomposition process, and second

decomposition range have temperature of 325-994 °C with 84.6% mass loss. The DTA data is given in Table 2 below. The results show that the total mass loss takes place in the range of 89-995 °C.

Table 2.

DTA results of $[Ag(MAB)_2(BGK)]$

№	Temperature, °C	Lost mass, %	Decomposition rate of the substance, mg / min	The amount of energy consumed ($\mu V \cdot s / mg$)
1	50	0,925	0,137	1,45
2	100	7,982	0,465	2,88
3	200	64,25	0,453	2,01
4	300	84,35	0,087	3,02
5	400	85,81	0,147	1,02
6	500	86,87	0,455	2,03
7	600	89,16	2,499	1,59
8	700	90,51	2,125	1,69
9	800	94,02	1,265	1,89
10	900	96,58	2,698	3,02
11	1000	99,33	1,235	2,05

The DTA of the $[Ag(MAB)_2(DEDTK)]$ complex compound shows similar trend. The initial decomposition temperature of $[Ag(MAB)_2(DEDTK)]$ is 149.40 °C. First decomposition range is 150-512 °C, and second decomposition range is 544-715 °C. The basic mass loss occurs in the range of 154-745 °C resulting to full thermolysis, the silver oxide remains as a residue.

Conclusion. For the first time, mono- and mixed coordination compounds of silver (I) with MAB and

DiPDTF, BGK, DEDTK were synthesized. The composition and structure of the synthesized complex compounds were studied by element, SEM-EDX, thermal analysis and FTIR-spectroscopic method. The synthesized complex compounds have silver ion binds MAB by monodentate mode via endocyclic nitrogen atom of the heterocycle, and the secondary ligands (DiPDTF, BGK, DEDTK) coordinated by bidentate mode forming tetrahedral coordination compounds.

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ДЛЯ ЗАМЕТОК

Научный журнал

**UNIVERSUM:
ХИМИЯ И БИОЛОГИЯ**

№ 7(85)
Июль 2021

Часть 2

Свидетельство о регистрации СМИ: ЭЛ № ФС 77 – 55878 от 07.11.2013

Издательство «МЦНО»
123098, г. Москва, улица Маршала Василевского, дом 5, корпус 1, к. 74
E-mail: mail@7universum.com
www.7universum.com

Отпечатано в полном соответствии с качеством предоставленного оригинал-макета в типографии «Allprint»
630004, г. Новосибирск, Вокзальная магистраль, 3

16+