https://doi.org/10.33472/AFJBS.6.11.2024.1108-1116

AFJBS African Journal of Biological Sciences
Journal homepage: http://www.afjbs.com

Research Paper Open Access

CHANGES IN THE BIOCHEMICAL COMPOSITION OF ARTEMISIA DIFFUSA AT DIFFERENT GRAZING INTENSITIES

Sh. A. Valiyev[1], T.F. Rajabov[2], M.G. Nasirov[2], M. M. Muminov[3], A.N. Khujanov[2], F. Dj. Kabulova[2], S.Kh. Urokov[2], Sh.M. Adizov[4], T.S. Urozov[1]

[1,9]Institute of Agrobiotechnology and Food Securite of Samarkand State University named after Sharof Rashidov Janboy district, Uzbekistan
[2,3,5,6,7]Department of Plant Physiology and Microbiology, Institute of Biochemistry of Samarkand State University named after Sharof Rashidov, 140 104, Samarkand City, Uzbekistan.
[3]Tashkent Institute of Irrigation and Agricultural Mechanization Engineers" National Research University
[4]Institute of the Chemistry Plant Substances named after Academician Yunusov S.Yu. of the Academy of Sciences of the Republic of Uzbekistan.

Email: valiyev_89@list.ru

Article Info

Volume 6, Issue 11, July 2024

Received: 23 May 2024

Accepted: 20 June 2024

Published: 09 July 2024

doi: 10.33472/AFJBS.6.11.2024.1108-1116

ABSTRACT:
The study investigates the impact of varying grazing intensities on the biochemical composition of Artemisia diffusa, a key species in rangeland ecosystems. Grazing, an essential ecological process, can significantly influence plant biochemistry, affecting both nutritional value and ecological interactions. This research was conducted in a semi-arid Karnabchul desert rangelands, where A. diffusa samples were collected from plots subjected to different grazing intensities: (low grazing and heavy grazing). Biochemical analyses focused on key constituents such as crude protein, fiber, carbohydrates including. The results indicated significant variations in the biochemical composition of A. diffusa across different grazing intensities. Light grazing led to a moderate increase in protein and carbohydrate contents, enhancing the plant's nutritional value. In contrast, heavy grazing caused a reduction in these protein and carbohydrate but significantly not change the concentrations of fiber, likely as a defensive response to grazing pressure.

Keywords: Artemisia Diffusa, Grazing Intensities, Biochemical Composition, Protein, Carbohydrates.

1. INTRODUCTION

All world, ensuring the integrity and stability of rangeland ecosystems, preserving the ecological and economic functions of rangelands is becoming one of the global social tasks [1]. Especially in nowadays climate change situation, the vegetation and soil cover of rangeland provide ecological services necessary for human life and make a significant contribution to global food security [2]. Accordingly, it is important to regularly monitor the natural state of rangelands, to identify ecological and physiological indicators of regressive changes occurring in the plant community, and to develop measures to prevent degradation processes and preserve the natural state of rangelands is important [3].

Changes in the natural state, productivity and nutritional parameters of rangeland plant communities under the influence of overgrazing, the chemical composition of nutritious dominant species in rangelands with different of livestock grazing intensities, the quantitative and qualitative indicators of plant substances at different levels undergoing changes [4]. Overgrazing threatens the preservation of ecosystems by excessive defoliation or trampling of vegetation and indirectly increases the impact on soil structure, which leads to the acceleration of desertification processes [5]. Different levels of grazing lead to negative changes in the structure, physicochemical, moisture, and organic matter of the rangeland soil [6]. As a result of the trampling of the surface layer of the soil by livestock hooves, it makes it difficult to restore the soil as a result of the intensification of soil erosion processes [7, 8]. The eating of the morphological parts of plants by livestock, and the cutting of bushes and semi-shrubs by people as firewood accelerated the degradation processes of rangeland ecosystems. Such anthropogenic factors have a negative effect on the growth and development of plants, especially in arid regions [9]. Overgrazing by livestock can lead to the degradation of the rangelands and create conditions that are favorable for invasive species [10].

In addition, climate change, that is, an increase in temperature, can have a negative effect on plants. According to the International Panel on Climate Change (IPCC), global temperatures are expected to increase by 1.0-3.7 °C by 2100 [11]. The combined effects of climate change and overgrazing on plant productivity, phenology, and ecosystem characteristics are also known from the literature [12, 13]. Several studies of geothermally heated areas in Iceland show that soil warming affects plant phenology, with plant phenology accelerating with increasing temperature [14]. For example, early flowering in spring and not continuing a long growing season [15, 16].

Natural rangelands have served as the main source of food for both natural herbivores and livestock during the past centuries in Uzbekistan [17]. The policy of gross collectivization of agriculture that was carried out by the former Soviet government in the 1930s disrupted the ancient nomadic pastoral system in Uzbekistan and its centuries-old traditions in the rangeland areas [18]. The policy of gross collectivization of agriculture lasted from the 1930s to the 1990s [19]. More than 21 million ha are used as rangelands in Uzbekistan, which is about 52% of the country's total land area [18, 20]. Unfortunately, 50-78% of existing rangelands have been degraded due to overgrazing [9]. Unsustainable grazing and trampling, especially around settlement areas, cause biodiversity loss and rangeland degradation [21]. Such livestock overgrazing is at present also a problem in many countries of Central Asia [22, 23].

One of the main reasons for the deterioration of the recent natural condition of rangelands in Uzbekistan is the sharp increase in the number of livestock [19]. It has been growing steadily over the last 30 years. For example, 10 million heads of small-horned cattle and 5 million heads of large-horned cattle were kept at farms in 1990, but this number had increased to 23 and 15 million by 2020 respectively [24]. This has clearly posed an increased anthropogenic pressure on the rangelands (Rahimova 2019), together with the negative effects of rapid climate change [25].

Such a complex situation calls for the development of sustainable rangeland management practices based on sound scientific knowledge.

2. MATERIALS AND METHODS

Site description

The Karnabchul semi-desert stretches 120 km from west to east in the territories of Samarkand and Navoi regions of Uzbekistan, the average width is 40-50 km, the average elevation above sea level is 300 m, there are several rows of hills from the southeast to the northwest, which are separated from each other by dry streams [26]. Karnabchul semi-desert is located at the foot of the Zyrubulok mountains according to its natural-geographical location (Fig.1).

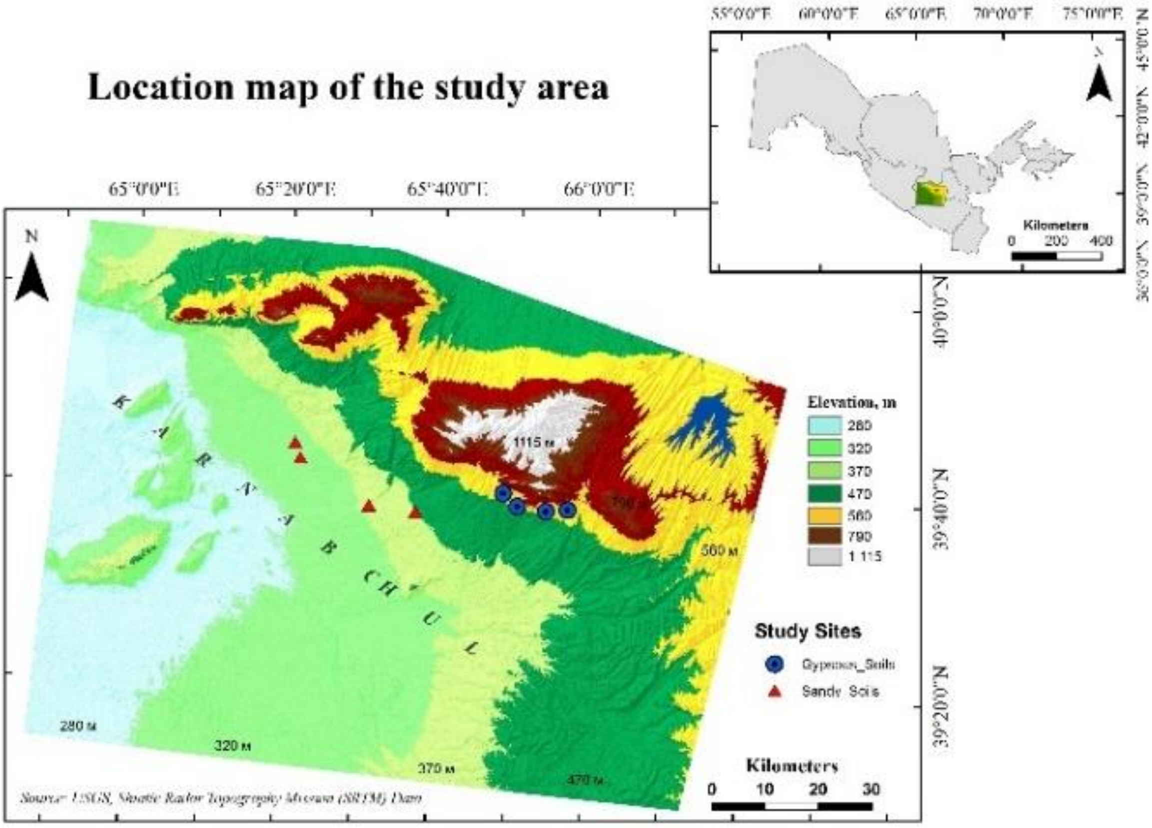

Figure 1. Location and elevation indicators of study sites of Karnabchul semi-desert of Uzbekistan.

In the south of Karnabchul, the Karshi steppes border the Bukhara oasis from the west and the Jom hills from the east, with a total area of 500,000 ha [18]. In the part of the Karnabchul semi-desert located in the Samarkand region, there are large settlements such as Sepki, Tim, Agron, Sakhoba, Tutli, and Gobdin [27]. The climate of the Karnabchul semi-desert differs from the dry continental climate of all the deserts of Central Asia [28]. The average annual temperature is +17.1°C (Fig. 2). The average temperature in June-July is 29-35°C, the lowest temperature is observed in December and February, sometimes it drops to minus 10-20°C, the average annual amount of precipitation is 140 mm [29]. According to the modern Köppen-Geiger classification, the natural climate of the Karnabchul semi-desert belongs to the cold arid desert climate region [30].

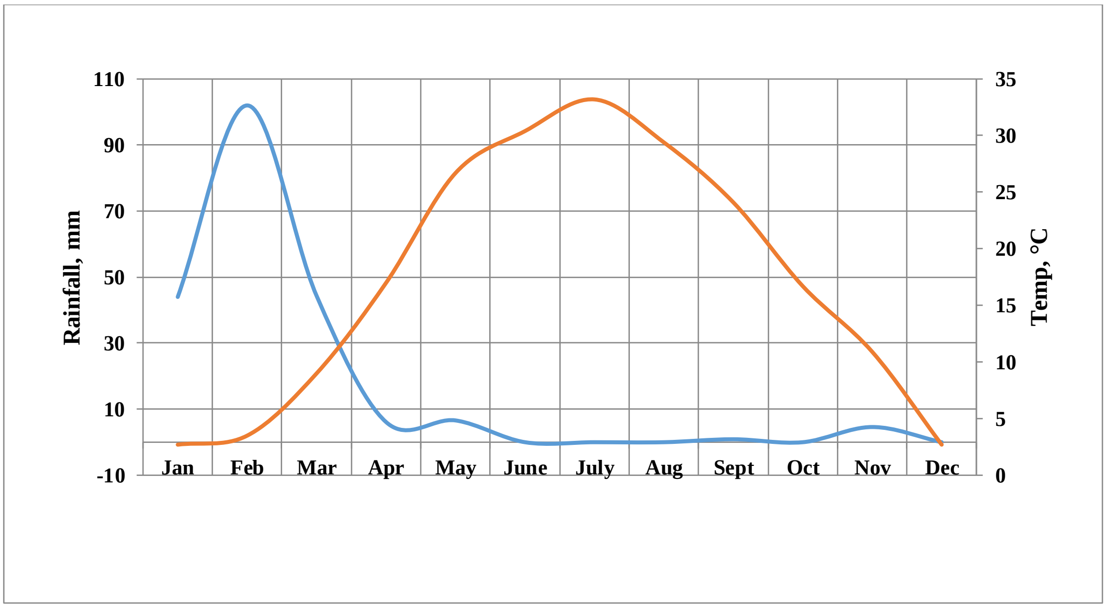

Figure 1. rainfall and temperature of the studied area, the blue line is rainfall, and the orange line is temperature.

Experimental Design. The samples were studied in the laboratory of the Chemistry of High-Molecular Plant Substances of the Academy of Sciences of the Republic of Uzbekistan.

The plants used as the object of study were Artemisia diffusa - No. 1 - low grazing, No. 2 heavy grazing.

Protein was determined using the accelerated Kjeldahl method with Nessler reagent [31]. Quantitative determination of protein. Apparatus, materials and reagents. FEC or SF, laboratory mill, analytical balance with an accuracy of 0.0001 g, filter paper, white tape, conical funnels, 50 ml volumetric flasks, sodium hydroxide, sodium potassium tartrate (Rochelle salt), Nessler's reagent, distilled water, sulfuric acid concentrated, concentrated hydrogen peroxide.

Conducting analysis. Determination of protein content in samples No. 1 and No. 2 was determined after preliminary mineralization of the sample with sulfuric acid, followed by determination of protein nitrogen with Nessler's reagent. To identify the protein, samples were ground into powder using an electric mill until the cell walls were destroyed, obtaining a homogenate. Weighed samples were taken from the prepared samples into heat-resistant flasks, concentrated sulfuric acid H_2SO_4 (ρ 1.84 g/cm) was added and decomposed on a sand bath or hot plate, avoiding violent boiling. The end of the mineralization process was the receipt of an absolutely transparent, colorless solution. In the prepared samples, the protein content was determined by the colorimetric method with Nessler's reagent at a wavelength of 400 nm. on the spectrophotometer V-5000 Metash. [32].

Fiber release.

Samples crushed to a size of 5-6 mm. 3 g of the plant (crushed and dried) were poured into 50 ml of the mixture (HNO_3 conc. -20 mm and 400 ml of 80% CH_3COOH) boiled for 45 minutes, the fiber was filtered, washed with 50 and 80% alcohol until neutral; dried. Isolation of the sum of high molecular weight polysaccharides:

Isolation of low molecular weight carbohydrates. Water-soluble, pectin substances and hemicelluloses. Dried and crushed raw materials, 20 g each, were extracted with boiling 820 alcohol for 30-45 minutes. Twice (150 ml, 100 ml)

The extracts were combined, evaporated to a small volume and analyzed by paper chromatography, on FN paper - 11, system -n-butanol - pyridine - water (6:4:3), developers acid aniline phthalate for hexoses and 5% urea solution for identifying fructooligosaccharides (FOS), sucrose and fructose.

Isolation of high molecular weight carbohydrates. The remaining raw materials after extraction with 820 alcohol were treated with a 5% NaOH solution twice, 150 and 100 ml at room temperature, constantly stirring for 30-45 minutes. The extracts were combined, neutralized with 50% CH_3COOH, then dialyzed against water for 48 hours. Next, the solutions were evaporated to a small volume and precipitated with alcohol (960) in a ratio of 1:3, the precipitates were separated by filtration, washed and dried with alcohol.

Data analysis.
For all analyses, the statistical software R was used (R Development Core 2023, version 4.2.2). The obtained results were checked separately for each grazing intensity and soil condition using ANOVA analysis. ANOVA test indicates that the mean difference exceeds the least significant difference ($P<0.05$) across all treatment levels. Significant interactions indicate that there are also significant responses between the treatment levels.

3. RESULTS

The biochemical composition of plants is one of the main factors that indicate its nutritional value. It is possible to determine the nutritional needs of livestock and develop a scientifically based system of rational grazing only when the biochemical composition of rangeland plants is known. This, in turn, increases the potential productivity of animals and serves to increase the efficiency of the use of nutrients. Currently, scientists have studied the biochemical composition and other nutritional properties of rangeland nutritious plants [33]. In recent years, scientists have studied the biochemical properties of non-traditional nutritious plants under the conditions of introduction in the Aral Bay region, and are trying to implement measures for production [34]. However, in recent years, there have been no studies on changes in the biochemical composition of A. diffusa, which is the main nutritious plant in Karnabchul semi-desert rangelands, depending on the changes in different grazing conditions. In the course of our research, the biochemical status of A. diffusa was studied in rangelands with high and low grazing intensities.
ANOVA analysis of the results of our study revealed that the of grazing intensities has a significant effect ($p<0,05$. Tabele 1).

Tabele 1. Assessment of grazing intensities, biochemical composition and combined effects

ANOVA	F-qiymat	P-qiymat
Grazing intensities	402,8	<0,038
Biochemical composition	821,4	<0,001
Grazing intensities x Biochemical composition	564,1	<0,023

When determining the biochemical status of A. diffusa, changes in the amount of main proteins, total nitrogen, total low-molecular and high-molecular carbohydrates were determined. Carbohydrates are the main energy sources and components of plants. Proteins play a role in carbohydrate metabolism, such as enzymes involved in glycolysis, gluconeogenesis, or the pentose phosphate pathway. Protein changes can affect these metabolic pathways and thus affect the total carbohydrate content of the plant. Proteins in A.diffusa in the pastures at the initial grazing intensity of cattle amounted to 6,83%. From the analysis of the obtained results, it was found that one g of A. diffusa contains an average of 4.3% proteins in rangelands with a high grazing intensities. It was found that the amount of proteins of A. diffusa in rangelands with high intensity of livestock grazing differs significantly from rangelands with low grazing intensities (Table 2).

Table 2. Results of analysis of total proteins of Artemisia diffusa in rangelands with low and high grazing intensities

Plant species	Grazing intansities	Protein content, %	Nitrogen content, %
Artemisia diffusa	Low grazing	6,87±0,45	1,09±0,15
Artemisia diffusa	High grazing	4,3±0,02	0,68±0,01

The amount of analyzed protein was found to contain 1,09% of nitrogen in A. diffusa from rangelands at the of low grazing intensities. It was found out from the results of the analysis that the protein obtained from A. diffusa in rangelands with a high grazing intensities is 0,68% nitrogen on average. With the increase of livestock grazing intensities, the amount of protein decreases significantly. The results of this study show that excessive livestock grazing significantly reduced total nitrogen content in annual leaves and assimilatory of A. diffusa dominant species compared to low grazing intensities. This may be due to livestock consuming important vegetative parts of A. diffusa, which leaves less reserve for regrowth and lowers total protein concentration. A high protein content usually indicates good forage quality. The decrease in protein content indicates that the forage quality of A. diffusa is impaired at high grazing intensities. This shows that the increase in grazing intensities has a negative effect on the protein composition of A. diffusa. High grazing intensities may result in reduced growth or metabolic processes, leading to reduced protein synthesis or accumulation. Proteins in one g of A. diffusa in pastures with low grazing intensities were 6.87%.

In the analyzed amount of protein, it was found that one g of A. diffusa in rangelands at the low grazing intensities contains 1,09% nitrogen. Analysis of the protein content of A. diffusa in rangelands with high of livestock grazing intensities revealed 4,3% proteins and 0,68% nitrogen during research. It was found that the amount of total carbohydrates in the nutritious A. diffusa of Karnabchul desert rangelands at low and high levels grazing intensities was significantly influenced by livestock grazing intensities. It was found that low and high levels of livestock grazing intensities affect the amount of total carbohydrates of A. diffusa. It was revealed from the results of the analysis that at low levels of grazing intensities, the amount of low molecular weight carbohydrates is 5% per one gram of dry weight. At high levels of grazing intensities, the amount of low-molecular carbohydrates per one g of dry mass was found to be 3,3% (Table 3).

Table 3. Results of total carbohydrate analysis of Artemisia diffusa in low and high of livestock grazing intensities

Plant species	Grazing intansities	Low Molecular Carbohydrates %	High molecular carbohydrates, %	Fiber %
Artemisia diffusa	Low grazing	5,0±0,35	13,5±0,62	40,0±2,2
Artemisia diffusa	High grazing	3,3±0,5	7,5±0,42	38,3±1,7

Analyzing our results, different levels of grazing intensities affect the composition of carbohydrates in the diet of A. diffusa, with low grazing intensities leading to higher percentages of low and high molecular weight carbohydrates. Low molecular weight carbohydrates are mostly simple sugars and soluble forms of carbohydrates. The decrease in their content under high grazing intensities suggests that plants can use these sugars for immediate energy or convert them into other forms to cope with grazing stress. Different levels of grazing intensities have a significant effect on the content of high molecular carbohydrates of A. diffusa. At low levels of grazing intensities, it was found that the amount of high-molecular carbohydrates is 13,5% based on one gram of dry weight. At high levels of grazing intensities, a significant reduction of 7,5% of the dry mass of 1 gram of A. diffusa was observed. The amount of total fiber was observed to decrease due to changes in different levels of grazing intensities. At low levels of grazing intensities, it was found to be up to 40% of one gram of dry mass, while at high levels of grazing intensities, the amount of total fiber decreased to 38,3%. The data obtained during the research show changes in the total carbohydrate content and fiber content of A. diffusa depending on the of livestock grazing intensities. These changes are important for assessing the nutritional quality of the forage and its potential nutritional value for grazing intensities. An increase in the of grazing intensities leads to a decrease in easily digestible carbohydrates and can increase the proportion of more complex carbohydrates and fibers in the plant. According to research conducted by a group of Chinese scientists, overgrazing in rangelands changed the activity of enzymes related to nitrogen assimilation, resulting in a decrease in the amount of proteins and nitrogen [35].

4. CONCLUSIONS

Grazing intensity significantly affects the biochemical composition of Artemisia diffusa. These biochemical changes have profound effects on plant health, reproduction, and the broader ecological context. High intensities of animal husbandry has led to depletion of essential nutrients such as proteins and carbohydrates as livestock consumption increases. These findings underscore the importance of considering biochemical responses in the management of grazing systems to promote sustainable agriculture and ecosystem health. Further research is needed to better understand the changes in the biochemical composition of grazing intensities.

5. REFERENCES

1. O‘Mara FP 2012. The role of rangelands in food security and climate change. Pub Med 110:263–270
2. Liu J, Feng Ch, Wang D, Wang L, Wilsey B, Zhong Zh 2015. Impacts of grazing by different large herbivores in grassland depend on plant species diversity. Journal of Applied Ecology, 53:1053– 1062
3. Kohli M, Mijiddorj N, Suryawanshi R, Mishra C, Boldgiv B, and Sankaran M 2021. Grazing and Climate Change Have Site-dependent Interactive Effects on Vegetation in Asian Montane Rangelands. Ecological Applications. 58:539–549
4. Tegegn A, Kassahun A, Nigatu L, Gmeskel K 2010. Plant Species Composition, spatial distribution, and diversity along a grazing Gradient from livestock watering point in Allaidege rangeland of North-Eastern Ethiopia rangelands. Journal of the drylands 3: 226-233
5. Barger N, Ojima S, Belnap J, Shipping W, Yanfen W, Chen Z 2004. Changes in plant functional groups, litter quality, and soil carbon and nitrogen mineralization with sheep grazing in an inner Mongolian rangeland. Range Management 57:613–619

6. Zarekia S, Jafari M, Arzani H, Javadi S, Jafari A 2012. Grazing effects on some of the physical and chemical properties of soil. World Applied Sciences Journal 2:205–212
7. Zhao L, Zhao Y, Zhou L, Zhang H, Drake S 2005. Desertification processes due to heavy grazing in sandy rangeland, Inner Mongolia. Journal of Arid Environments 62:309–319
8. Arnalds O, Barkarson BH (2003) Soil erosion and land use policy in Iceland in relation to sheep grazing and government subsidies. Environmental Science & Policy 6:105–113
9. Rakhimova T 2019. Koʻkcha yaylovlarining hozirgi holati [Current condition of Kukcha rangelands]. Pages 334–337. In: Yusupov S, Rabbimov A, Mukimov T (eds) Karakul Sheep of Kyzylkum rangelands and ways of their rational use. Arid Ecosystems 2010: The scientific and practical basis of desert rangelands development and prevention of desertification, Proceedings of the international scientific and practical conference 14–15 August 2019. Samarkand, (in Uzbek)
10. Rajabov T, Ramsey R, Mardonov B, Nasirov M, Rakhimova T, Valiev S (2020) Sensitivity of Landsat 7 & 8-derived vegetation indices on semi-arid rangelands of southwestern Uzbekistan. Geocarto International 37:510-525
11. IPCC 2023. Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change IPCC, Geneva, Switzerland. doi: 10.59327/IPCC/AR6-9789291691647.001
12. Klein J, Harte J, Zhao Q 2007. Experimental Warming, Not Grazing, Decreases Rangeland Quality on the Tibetan Plateau. Ecological Applications. 17 541–557
13. Kohli M, Mijiddorj N, Suryawanshi R, Mishra C, Boldgiv B, and Sankaran M 2021. Grazing and Climate Change Have Site-dependent Interactive Effects on Vegetation in Asian Montane Rangelands. Ecological Applications. 58:539–549
14. Valdés A, Marteinsddéttir B, Ehrlén J 2019. A natural heating experiment: Phenotypic and genotypic responses of plant phenology to geothermal soil warming. Global Change Biology, 25(3), 954-962
15. Bellard C, Bertelsmeier C, Leadley P, Thuiller, W, Courchamp F 2012. Impacts of climate change on the future of biodiversity. Ecology Letters, 15(4), 365–377
16. Parmesan C 2006. Ecological and Evolutionary Responses to Recent Climate Change. Annual Review of Ecology, Evolution, and Systematics, 1: 637–669.
17. Baret F, Guyot G 1991. Potentials and limits of vegetation indices for LAI and APAR assessment. Remote Sensing of Environment 35 p. 161–173.
18. Gintzburger G, Toderich K, Mardonov B, Mahmudov M 2003. Rangelands of the arid and semi-arid zones in Uzbekistan. CIRAD-ICARDA, Paris
19. Naumov Y, Pugach I 2019. Проблемы и перспективы развития животноводства в Узбекистане [Problems and prospects for the development of animal husbandry in Uzbekistan]. Pages 6–23 Discussion Paper, (IAMO), Halle Salle Germany, (in Russian)
20. Dong S, Wen L, Liu S, Zhang X, Lassoie JP, Yi S, Li X, Li J, Li Y 2011. Vulnerability of Worldwide Pastoralism to Global Changes and Interdisciplinary Strategies for Sustainable Pastoralism. and Society
21. Rajabov T 2009. Ecological assessment of spatio-temporal changes of vegetation in response to poisphere effects in semi- arid rangelands of Uzbekistan. Land Restoration Training Programme Keldnaholt, 112 Reykjavík, Iceland [Final project]
22. Yusupov U 2003. Взаимодействие животноводства и пустынной среды в Узбекистане [Interaction between livestock and the desert environment in Uzbekistan]. Pages 93-96. In: Schrader F, Alibekov L, Toderich K (eds) Proceedings of NATO Advanced Research Workshop, "Desertification Problems in Central Asia and its Regional Strategic Development" Samarkand, Uzbekistan, 11-14 June 2003. Deutsche National Bibliography, Berlin (in Russian)

23. Aw A, Korol V, Nishanov N, Dubovyk O, Mirzabaev A 2015. Economics of Land Degradation in Uzbekistan. Zentrum für Entwicklungsforschung (ZEF), Bonn
24. Rajabov T. F. 2022. Ecological-phytoccoenotical assessment of transformation of semi-desert rangeland vegetation of Uzbekistan (in the case of Karnabchul) (Doctoral dissertation) Samarkand state university, Samarkand, Uzbekistan
25. Godde M, Boone B, Ash J, Waha K, Sloat L, Thornton K, Herrero M 2020. Global rangeland production systems and live lihoodsat threat under climate change variability. Environmental research letter 15: 044021
26. Valiyev Sh, Rajabov T, Avutkhanov B, Ataeva Sh 2023. Changes of photosynthetic pigments of Artemisia diffusa under the influence of grazing stress of livestock grazing in Karnabchul semi-desert, Uzbekistan. Plant science today 2348-1900 https://doi.org/10.14719/pst.2430
27. Rajabov T, Artykov T, Rakhimova T, Valiev Sh, Abdurakhmanov Z, Allayarov M 2021. Changes in desert rangeland soil conditions as a result of livestock grazing. Karakalpakstan Department of the Academy of Sciences of the Republic of Uzbekistan 3: 70-75
28. Valiyev Sh, Rajabov T, Mardonov B, Nasirov M 2020. Analysis of seasonal changes of plant communities using vegetation index indicators (in the case of Karnabchul). Pages 73-76, In: Rakhimova T(eds) Current condition of Kukcha rangelands 2019: Food Security: national and global factors Proceedings of the 2nd International scientific-theoretical conference October 16-17. Samarkand, (in Uzbek)
29. Rajabov T, Artykov T, Rakhimova T, Valiev Sh, Abdurakhmanov Z, Allayarov M 2021. Changes in desert rangeland soil conditions as a result of livestock grazing. Karakalpakstan Department of the Academy of Sciences of the Republic of Uzbekistan 3: 70-75
30. Kottek M, Grieser J, Beck C, Rudolf B, Rubel F 2006. World Map of the Köppen-Geiger climate classification updated. Meteorological Zeitschrift. 3:259-263
31. Ermakov A.I., Arasimovich V.V. 1982. In the book: Methods of biochemical research of plants M. p. 430.
32. G.F, Mashkovsky M.D, Babayan E.A. 1989. Spectrophotometric method for protein determination. In the book: State Pharmacopoeia of the USSR. M., p.392.
33. Larin I.V., Agababyan Sh.M., Rabotnov T.A., Larina V.K., Kasimenko M.A., Lyubskaya A.F. Kormovye rasteniya senokosov i lowbishch USSR. - M.-L.: Selkhozgiz, 1956. T.3. - S. 710-718.
34. Toderich K.N., Bobokulov N.A., Rabbimov A.R., Shuyskaya E.V., Mukimov T.Kh., Popova V.V., Khakimov 2014. U.N. Kochia prostrata (L.) Schrad is a valuable fodder plant for growing desert and semi-desert pastures. - Tashkent: Science and technology. 107-121.
35. Zhu A., Liu H., Wang H., Sun H., Han G. 2021. Grazing intensity changed the activities of nitrogen assimilation related enzymes indesert Steppe Plants // Plant Biology. 21 436-449.