PHARMACOLOGICAL ANALYSIS OF THE RAW MATERIAL OF FENUGREEK (*TRIGONELLA FOENUM-GRAECUM* L.)

***Abdurakhmonova Diyora Abdullo qizi*[1]**

[1]*Tashkent State Agrarian University, Bachelor student of "Technology of cultivation and processing of medicinal plants" Tel. +99877-293-02-04. E-mail: abduraxmonova246@gmail.com*

***Mardonov Fozilbek Mardon o'g'li*[2]**

[1]*Senior Lecturer, Tashkent State Agrarian University, Department of Medicinal Plants*

Tel. +99899-026-41-41. E-mail: m.fozilbek@bk.ru

***Aminov Salaxitdin Djurayevich*[3]**

[2]*Professor, Tashkent State Medical University,Head of the Department of Pharmacology, Clinical Pharmacology. Tel. +99890-316-41-84. E-mail: s.aminov@gmail.com*

Abstract: *In this study, the morphological, biological, agropharmacological properties and pharmacological properties of the seeds of Fenugreek (T. foenum-graecum L.), grown in the conditions of Uzbekistan, were analyzed in depth. From Jumala, the morphological parameters of Greek Shambhala seeds were determined, such as seed length (5-6 mm), width (2-3 mm), weight of 1000 seeds (15.4-15.7 g). Specific biological and biomorphological characteristics of seeds have been determined. It has been established that the seeds of the plant can be distinguished from other seeds by color and appearance, as well as the presence of a pink and black crescent-shaped dot at the tip. It has been established that the plant T. foenum-graecum can be effectively grown in the conditions of Uzbekistan, obtain regular seed raw materials and prepare medicines for the pharmaceutical industry and medical institutions.*

The main study, the acute toxicity of the seeds of the Greek Shambhala plant, was also pharmacologically analyzed. According to him, exposure of an animal

(white mouse) to a dry extract of Fenugreek (T. foenum-graecum L.) in low doses (1000 mg/kg, 2000 mg/kg and 3000 mg/kg) led to a decrease in mobility for some time. It was noted that there will be no changes in the next stages. Exposure to high doses (4000 mg/kg and 5000 mg/kg) revealed a decrease in mobility and behavior in response to external stimuli (i.e., reactions to light, mechanical stress, forced movement, food and water intake, and attitudes towards relationships did not deviate from the physiological norm). Changes in symptoms were observed over a short period of time in a dose-dependent manner, quickly returning to the intact state. During the first 7 days of the study, all animals (mice) participating in the experiment were active and no pathological changes, including death, were observed. According to the indicator of acute toxicity of the seeds of the Fenugreek plant (T. foenum-graecum L.), LD50 is more than 5000 mg/kg, and according to the toxicity category (Stefanov A.V., 2002) it has been established that it belongs to class V group, i.e. practically non-toxic substances.

Key words. *Fenegreek, medicinal, seed, symptom, trigonella, agropharmacology, color, weight, pharmacology, pharmaceutical, dose, intact, animal, pathology, poison, category.*

ФАРМАКОЛОГИЧЕСКИЙ АНАЛИЗ СЫРЬЯ РАСТЕНИЯ ПАЖИТНИК СЕННОЙ (*TRIGONELLA FOENUM-GRAECUM* L.)

Абдурахмонова Диёра Абдулло кизи[1]

[1]*Ташкентский государственный аграрный университет, студент бакалавриата направления «Технология выращивания и переработки лекарственных растений»,*

Tel. +99877-293-02-04. E-mail: abduraxmonova246@gmail.com

Мардонов Фозилбек Мардон угли[2]

[1]*Старший преподаватель кафедры «Лекарственные растения»* Ташкентского государственного аграрного университета, Тел. +99899-026-41-41. E-mail: m.fozilbek@bk.ru

Аминов Салахитдин Джураевич[3]

[2]Профессор, Ташкентская государственная медицинская академия, заведующий кафедрой фармакологии и клинической фармакологии. Тел. +998 90-316-41-84.

E-mail: s.aminov@gmail.com

Аннотация: *В данном исследовании углубленно проанализированы морфоло-гические, биологические, агрофармакологические свойства и фармакологические свойства семян шамбалы греческой (T. foenum-graecum L.), выращенной в условиях Узбекистана. Из Джумалы определяли морфологические показатели семян греческой шамбалы, такие как длина семян (5-6 мм), ширина (2-3 мм), масса 1000 семян (15,4-15,7 г). Определены специфические биологические и биоморфологические характеристики семян. Установлено, что семена растения можно отличить от других семян по цвету и внешнему виду, а также наличию на кончике розовой и черной точки в форме полумесяца. Установлено, что растение T. foenum-graecum можно эффективно выращивать в условиях Узбекистана, получать регулярное семенное сырье и готовить лекарственные препараты для фармацевтической промышленности и медицинских учреждений.*

Также фармакологически проанализировано основное исследование - острая токсичность семян растения шамбала греческая. Согласно ему, воздействие на животное (белую мышь) сухого экстракта шамбалы греческой (*T.foenum-graecum* L.) в низких дозах (1000 мг/кг, 2000 мг/кг и 3000 мг/кг) приводило к снижению подвижности на некоторое время. Было отмечено, что на следующих этапах изменений не будет. Воздействие высоких доз (4000 мг/кг и 5000 мг/кг) выявило снижение подвижности и поведения при внешних раздражителях (т.е. реакции на свет, механическое воздействие, вынужденное движение, прием пищи и воды, отношение к взаимоотношениям не отклонялись от физиологической нормы). Изменения симптомов наблюдались в течение короткого периода времени в зависимости от доз, быстро

возвращаясь в интактное состояние. В течение первых 7 дней исследования все животные (мыши), участвовавшие в эксперименте, были активны и патологических изменений, включая гибель, не наблюдалось. По показателю острой токсичности семян растения шамбала греческая (T. foenum-graecum L.) ЛД50 составляет более 5000 мг/кг, а по категории токсичности (Стефанов А.В., 2002) установлено, что оно относится к группе V класса, т.е. практически нетоксичных веществ.

Ключевые слова. *Пажитник, лекарственный, семя, симптом, тригонелла, агрофармакология, цвет, масса, фармакология, фармацевтический, доза, интактный, животное, патология, яд, категория*.

Introduction. Today, medicinal plants constitute more than 750 species out of approximately 4,400 higher plant species found in Uzbekistan [1]. These species are distinguished by their diversity and bioecological characteristics. Each plant species possesses unique properties and is widely utilized in various fields. In particular, medicinal plants play a crucial role in human life, serving as effective tools for improving health and treating numerous diseases. Among them are medicinal plants containing polysaccharides (homo- and hetero-), vitamins (provitamins), terpenoids, alkaloids, saponins, glycosides, flavonoids, and other bioactive substances, as well as therapeutic plants with pharmacological effects such as analgesic, sedative, diaphoretic, carminative, anti-inflammatory, and others.

According to research and scientific developments, the raw materials of 304 types of medicinal plants are included in the State Pharmacopoeia of the Republic of Uzbekistan (SP RUz Vol. 3, Part 1/2), and their use in clinical and preclinical trials is officially authorized [5], [6]. In particular, the seed raw material of the Fenugreek (T. foenum-graecum L.) plant is also included in the aforementioned state register, and the use of its phytoproducts for pharmaceutical and medical purposes is officially permitted [6].

Currently, medicinal plant raw materials are actively used not only in the pharmaceutical industry but also in perfumery, cosmetics, and for various medical purposes. Additionally, some species serve as therapeutic dye plants, playing a vital

role in the production of colored medicinal forms for the industrial pharmaceutical sector. This plays an extremely important role in enhancing the stability and balance of drug production based on medicinal plants from both agropharmacological and pharmacological perspectives.

In the modern list of medicines, preparations derived from medicinal plants account for approximately 40%. Drugs produced from the plants on this list are essential for the healthcare system; due to their mild and gentle effects, they are often used more effectively compared to synthetically produced drugs. Bioactive substances obtained from medicinal plants serve as primary or supportive treatments for various diseases through a natural approach without harming the human body. For certain diseases, nearly 80% of the applied drugs are derived from plant raw materials. This, in turn, demonstrates the high significance of medicinal plants for medical purposes.

In recent years, the growing demand for medicinal plant raw materials and their bioactive substances is expected to further increase their utilization for medical purposes.

The Decree of the President of the Republic of Uzbekistan No. PF-139 dated May 20, 2022, 'On measures to create an additional value chain by supporting the effective use and processing of the medicinal plant raw material base,' the Resolution No. PQ-251 'On measures to organize the cultivation and processing of medicinal plants in a cultural manner and their wide use in treatment,' as well as the Resolution No. PQ-411 dated October 26, 2022, 'On additional measures to provide the population with quality medicines and medical devices,' are aimed at further developing research within the agropharmecological and pharmacological sectors. To ensure their implementation, relevant measures are being taken to establish cultivated plantations of medicinal plants, prepare plant raw materials, organize the supply of raw materials to the domestic market, and develop new medicinal forms. This, in turn, enhances efficiency in the production of medicinal plant raw materials, expands the database of preparations necessary for the pharmaceutical industry and

medical purposes, and enables the achievement of economically effective results [1], [2], [3], [4].

Literature Review. Globally, the demand for preparations derived from medicinal plants is increasing by 6-7% annually. According to international experts, their annual turnover exceeded $35 billion in 2020, and this figure has reached $48 billion today [7]. Countries such as China, India, Canada, and the USA consistently carry out extensive experiments on the preservation and cultivation of naturally growing medicinal plants. In the People's Republic of China alone, the average annual turnover of medicinal plants and medicines amounts to $100 billion (exports at $1 billion, imports at $274 million) [8].

This indicates a rising demand for medicinal plant raw materials and products, including Fenugreek (T. foenum-graecum L.). On a global scale, Fenugreek raw materials (seeds) and its derivatives are considered high-demand products. The world's leading exporters of Fenugreek seeds are India, China, and Morocco, with an annual export volume of 200-500 tons [7].

According to sources, Fenugreek raw material is included in the list of products with the highest potential in international trade. The United Kingdom is a major buyer of spice plant raw materials and imports large quantities of Fenugreek, primarily from India, China, Israel, and Spain. In the USA, Fenugreek seed imports amount to 500 tons per year, mostly sourced from India, Morocco, Israel, Pakistan, and China. In Belgium and Luxembourg, the annual import volume of Fenugreek raw material ranges from 10 to 40 tons [7], [8].

Over the past five years, the Fenugreek (Trigonella foenum-graecum L.) plant has been tested under introduction conditions (adaptation and acclimatization to various soil and climatic conditions) in the Republic, and its raw materials have been prepared. For instance, cultivation work on Fenugreek was carried out across various soil and climatic conditions in the Tashkent and Syrdarya regions. This plant is essential for meeting the needs of the pharmaceutical industry and producing high-quality phytoproducts. Ensuring the agropharmecological and pharmacological

systematization of this plant's phytoproducts and creating a robust base for raw material production will significantly contribute to Uzbek science and industry.

Establishing cultivated plantations of medicinal plants, processing them, and manufacturing medicinal forms will not only develop the medical field but also create new jobs and ensure sustainable development within the sector. Through this, the volume of medicinal plant production within the country will increase, creating opportunities for export to the international market.

Object and methodology of experience (research). As an object of research, legumes (Fabaceae Lindl.) family, the annual Fenugreek (Trigonella foenum-graecum L.) plant was selected. The seed raw material of this plant is of great agropharmacological and pharmacological importance. T.The foenum-graecum plant has a number of beneficial properties. For the study, the seeds of the Fenugreek plant (ecoforma of Pakistan), grown on the farms of the Tashkent State agrarian university, located in the Qibray district, Tashkent region, and “prosperous yurt gardens” of the Khovost District, Syrdarya region, were accepted. The seeds obtained were prepared for scientific research and were of good quality, meeting all the criteria required for use. The seeds used in this study provided high-quality samples that allowed for accurate observation of quality and process. The weight of the 1000 seeds used in the study was 15.4-15.7 g, which helped to determine the specific physical and biological characteristics of these animals. T. The morphological characteristics of the seeds of *T.foenum-graecum* L. indicate that they differ from other plants. The seeds are oblique rhomboid in shape and have uneven edges. The appearance of this seed determines the plant's ability to adapt to certain conditions. The seeds are brown or dark brown in color, 5-6 mm long and 2-3 mm wide (Table 1).

Fenugreek cultivated in Uzbekistan (*Trigonella foenum-graecum* L.) morphological

indicators of seeds

Plant seed	Size (mm)	1000 seeds weight/gr

scientific name	color	length	width	
Semina et Trigonella foenum-graecum L.	Yellow, orange-brown	5-6	2-3	15,4-15,7

Table 1

The seeds of this plant are used in folk medicine for pharmaceutical and medicinal purposes. Studying the agronomic and pharmacological properties of this plant will help to understand how it can be effectively used in various fields.

The research work was carried out in the relevant laboratory of the Tashkent Pharmaceutical Institute. This laboratory has the appropriate conditions for studying the experimental object. During the research, comprehensive data were collected based on observations in this laboratory. The MS-Excel program was used for statistical analysis, all the data obtained were processed according to generally accepted methodological criteria, and the relevant pharmacological parameters of Greek chamomile seeds were analyzed.

Results of the experiment (study) and their discussion. The study examined the level of acute toxicity of the seed raw material of the Greek chamomile (*T. foenum-graecum* L.) plant. For this, experiments were conducted on 30 white mice of both sexes, weighing 19-21 grams. Initially, a 20% suspension was prepared from the dry extract of Fenugreek seeds. This suspension was administered to a selected number of white mice for the experiment. They were given the suspension orally once a day (Table 2).

Procedure for administering a suspension of seeds of the plant Fenugreek

(*T. foenum-graecum* L.) to an animal's body

Table 2

№	Animal (mouse) type	Suspension sending method

	color	number/ pieces	mass /gr	sex	oral administration//dose/				
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1	Whit	30	19-21	Male/femal	100	2000	3000	4000	5000

In this experiment, white mice were examined from a physiological perspective for one hour initially, and then for 14 days, every day. In terms of the functional state of white mice, attention was paid to their general physiological state, movement coordination in hati movement, response to various external factors, body weight, external normal appearance of urine and feces, behavior, occurrence of various toxicological conditions, and observation of mortality during the experiment. During the experiment, white mice were kept in the vivarium in accordance with the requirements of the "GLP".

According to the results of the experiment, Fenugreek (*T.foenum-graecum* L.) when administered from dry extract to white mice, orally at doses of 1,000 mg/kg, 2,000 mg/kg, and 3,000 mg/kg, white mice were observed to have a small amount of low mobility in their movements during daslabki hours. Starting from the second day of the experiment, it was possible to observe the disappearance of these changes. With an increase in the doses of dry extract of the plant to be sent to animals, that is, according to the result of the administration of 4000 mg/kg and 5000 mg/kg, it became possible to see that there was little movement and movement with external influencers. That is, it was possible to observe that the effects of light, mechanical effects, forced movement, and attitudes towards the food and water provided did not deviate from the physiological norm (Table 3).

Acute toxicity of Greek fenugreek (T. foenum-graecum L.) seeds

Table 3

№	Animal (mouse)			*T. foenum-graecum* L. *20% li quruq ekstrakt*		
		color	mass, g	dose		death

	ordinal r			mg/kg	ml	the way to	
1.	1 2 3 4 5 6	White	19 21 20 19 21 20	1000	0,11 0,10 0,11 0,10 0,10 0,11	By mouth	0/6
2.	1 2 3 4 5 6	White	19 20 21 19 20 20	2000	0,19 0,20 0,21 0,19 0,20 0,20	By mouth	0/6
3.	1 2 3 4 5 6	White	20 20 21 19 20 21	3000	0,30 0,30 0,31 0,29 0,30 0,31	By mouth	0/6
4.	1 2 3 4	White	21 19 19 20	4000	0,42 0,38 0,38 0,40	By mouth	0/6

	5 6		21 21		0,42 0,42		
5.	1 2 3 4 5 6	White	21 20 21 20 20 21	5000	0,11 0,10 0,11 0,10 0,10 0,11	By mouth	0/6
		$LD_{50\geq}$ 5000 mg/kg					

Changes in these symptoms were short-lived and reversible to an intact state, depending on the dose. During the first seven days of the study, all of the white mice that were tested were active and showed no pathological changes. As such, no mortality was observed in white mice at the end of the experiment. Therefore, the Fenugreek (*T. foenum-graecum* L.) seed dry extract can be considered to have an LD50 greater than 5000 mg/kg. The results of the experiment are presented in Table 3.

Conclusion. This study thoroughly analyzed the morphological characteristics of raw materials of Greek fenugreek (*T.foenum-graecum* L.) grown in Uzbekistan. The morphological parameters of the plant seeds, such as seed length (5-6 mm), width (2-3 mm), and weight of 1000 seeds (15.4-15.7 g), were determined. The seeds have unique biological and biomorphological characteristics. The seeds are brown or dark brown in color and are distinctive in appearance, including a pink spot on the tip of the seeds. And it was found that the crescent is distinguished from other seeds by the presence of a black spot.

Results obtained in the study, T.The study shows that the foenum-graecum plant can be effectively grown in Uzbekistan, regularly producing seed raw materials, and can be used in the pharmaceutical industry and for the preparation of

medicines for medical purposes.

The environment plays a key role in helping this plant adapt to a new environment and learn how to prepare raw materials from it, as well as in increasing the efficiency of the production of medicines based on medicinal plants in Uzbekistan.

The results of the study were analyzed pharmacologically. In this study, Greek fenugreek (T.foenum-graecum L.) when exposed to animal (white mouse)at doses below dry extract (1000 mg/kg, 2000 mg/kg, and 3000 mg/kg), low mobility occurred in their movements for a period of time in the daslabki hours. On the second day of the experiment, these changes were not observed. When exposed to high doses (4,000 mg/kg and 5,000 mg/kg), movement with low mobility and external influences occurred-that is, it was observed that light, mechanical exposure, forced movement, given food and water, attitudes did not deviate from the physiological norm. Changes in these symptoms were short-lived and quickly returned to normal, depending on the dose. The study was conducted during the first 7 days, during which all the animals (mice) participating in the experiment were active and no pathological changes, including death, were observed.

Based on the above, Greek fenugreek (T.foenum-graecum L.) seeds are highly toxic, with an LD50 of more than 5000 mg/kg, and are classified as highly toxic (Stefanov A.V., 2002) It was found to belong to Class V, i.e., practically harmless substances.

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