

STUDYING THE AMOUNT OF HEAVY METALS IN THE FRUITS AND
SEEDS OF *PHYSALIS ANGULATA* BY THE ICP-MS METHOD

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Abstract

The *Physalis angulata* was studied using the mass spectrometry method for the content of heavy metals in fruits and seeds. Due to the low content of heavy metals in fruits and seeds, they are a safe raw material for creating biologically active additives.

Key words: *Solanaceae*, *Physalis angulata*, elements, mass spectrometry.

Introduction. The genus *Physalis* consists of annual or perennial plants and includes about 120 plant species. Representatives of *Physalis* are cultivated for industrial purposes in some countries [1-7]. *Physalis* fruits, leaves and roots have medicinal properties that are actively used in folk medicine [8-11].

The chemical composition of plants of the *Physalis* genus is, without exaggeration, unique. Plant fruits contain many active substances, in particular, vitamins, flavonoids, saponins, glycosides [12-15]. In the flora of Uzbekistan, the chemical composition of plant species belonging to the genus *Physalis* has not been studied until now. Several species of this family can be found in Uzbekistan. *Physalis angulata* is an annual herb growing 80-100 cm tall. Known as mullaca in Peru, Amazon. The main reason for the widespread distribution of *Physalis angulata* is that it is a tropical, subtropical and warm temperature plant [16-19].

Physalis angulata fruit extracts have been found to contain major phytochemicals such as alkaloids, tannins, glycosides, and phenolic compounds [20-24]. Zubair et al. analyzed the secondary metabolite composition of the plant extract, such as alkaloids, flavonoids, tannins, saponins, steroids, phenol. These metabolites were found to be present in n-hexane, chloroform, ethyl acetate, acetone and methanol extracts (except saponins) [25-31]. Several of these secondary metabolites have been reported to be responsible for the diverse medicinal properties of these plants. Some of these compounds have anti-pathogenic effects due to their antibacterial properties.

The purpose of this research work is to study the content of heavy metal salts of *Ph. angulata* plant by mass spectrometry method with inductively coupled argon plasma.



Materials and research methods. An accurate sample of 0.05-0.5 g is weighed on an analytical balance and transferred to Teflon autoclaves. Then the appropriate amount of purified concentrated mineral acids (nitric acid (reagent grade) and hydrogen peroxide (reagent grade)) is poured into the autoclaves. The autoclaves are closed and placed in a Berghoff microwave digestion device with MWS-3+ software or a similar type of microwave digestion device. Determine the decomposition program based on the type of substance being tested, indicate the degree of decomposition and the number of autoclaves (up to 12 pcs). After microwave decomposition, samples in autoclaves were placed in measuring flasks with a volume of 50 or 100 ml, and the volume of the solution was reached to the measurement mark of the flask with 0.5% HNO₃. The aliquota part from the prepared solution was measured and analyzed using inductively coupled plasma mass spectrometry.

The plant for research was collected in July 2020 from Kibrai district of Tashkent region. The plant was divided into organs, dried and crushed. The study of heavy metal salt content was carried out by inductively coupled plasma mass spectrometry (ICP-MS). Sample preparation was carried out using the method of wet acid-peroxide ashing on an X-Expert device.

For quantitative determination, standard solutions of multielements were used. To eliminate the background, the UCTTM quadrupole universal background elimination system was used in the range from 1 to 285 amu.

Analysis conditions: Device: NexION-2000. Perkin-Elmer with SyngistixTM software for ICP-MS (USA); argon gas flow – 15 l/min; peristaltic pump speed - 1.2 ml/min; detector – quadrupole mass analyzer; generator power – 1500W.

To verify the device, standard samples of solutions of elements GSO 7759-2000 (Be), GSO 7268-96 (Co), GSO 7252-96 (Pb), GSO 7472-98 (Cd) were used (relative error limits ($P = 0.95$) $\pm 1.0\%$). The experimental results are shown in Table 1.

Table 1

Data from a comparative analysis of the elemental composition of the fruit and seed of the plant *Ph. angulata*

№	Elementy	Fruit (mg/kg)	Seed (mg/kg)
1	Ag	0.0	0.0



2	Sb	0.0	0.0
3	Hg	0.0	0.0
4	Pb	2,2	2.048
5	Zn	22,5	35,6
6	Ni	7,3	7,3

Results. As can be seen from the table, silver, antimony and Mercury metals from heavy metal salts were not detected in the composition of fruits and seeds of the angulata plant. Lead, zinc and nickel metals were found to be in very small quantities.

Heavy metals and their compounds accumulate in tissues, causing a number of diseases. Elements such as zinc and nickel can be useful for some species in small concentrations.

Conclusion. The obtained data show that due to the very small amount of heavy metal, this plant species is a very safe and useful raw material for creating biologically active supplements.

References

1. Nnamani, Catherine Vera, Ani, Ogonna Christiana and Belunwu, Gregory. Larvicidal effects of ethanol extracts of leaves and fruits of *Physalis angulata* L. on the larvae of anopheles mosquitoes from Ebonyi state, Nigeria. // Animal Research International, 2009. 6(3): 1059 – 1062.
2. Растительные ресурсы СССР - Том V, 1990, 94 с.
3. А.И. Введенский, Флора Узбекистана - Том V (1961) 426-429 с.
4. Хикматуллаев, И. Л., Азимов, Н. Ш., Валиев, Н. В. Ў., Хужаев, В. У., & Аскарлов, И. Р. (2023). Стандартизация экстракта надземной части растения *Physalis alkekengi* для классификации в качестве товарного продукта. *Universum: химия и биология*, (1-1 (103)), 66-69.
5. Mezhlumyan, L.G., Khikmatullaev, I.L., Rakhimova, S.K. *et al.* Amino-Acid Composition and Hypoglycemic Properties of Proteins from *Physalis alkekengi* and *P. angulata*. *Chem Nat Compd* 58, 187–189 (2022). <https://doi.org/10.1007/s10600-022-03631-y>
6. Khikmatullaev, I.L., Boimatov, O.S., Yuldasheva, N.K. *et al.* Constituent Composition of *Physalis angulata*. *Chem Nat Compd* 58, 596–600 (2022). <https://doi.org/10.1007/s10600-022-03749-z>



7. Xikmatillayev, I. L., Matchanov, A. D., & Aripova, S. F. (2006). Study of elemental composition of *Physalis angulata* plant by ICP-MS method. *Биохимия и Биофизика*, 12.
8. Хикматуллаев Иззатулло Лутфуллоевич, Матчанов Алимжон Давлатбоевич, Хўжаев Ваҳобжон Умарович, & Арипова Салима Фозиловна. (2023). STUDY OF ELEMENTAL COMPOSITION OF *PHYSALIS ALKEKENGII* PLANT BY ICP-MS METHOD. *Scientific Journal of the Fergana State University*, (1), 3. https://doi.org/10.56292/SJFSU/vol_iss1/a3
9. Xikmatullayev, I. L., & Xo'jayev, V. U. (2020). *Physalis alkekengi* va *Physalis angulata* o'simliklari fitokimyoviy tarkibi (Phytochemical Composition of *Physalis alkekengi* and *Physalis angulata* Plants).
10. Xikmatullayev I. (2023). *PHYSALIS ANGULATA O'SIMLIGI VITAMIN TARKIBI TAXLILI. Theoretical and Experimental Chemistry and Modern Problems of Chemical Technology*, 1(01). Retrieved from <https://ojs.qarshidu.uz/index.php/ch/article/view/74>
11. Г.М. Дусчанова, Арипова С.Ф., И. Хикматуллаев, Равшанова М.Х., & М.А. Исабекова. (2023). АНАТОМИЧЕСКОЕ СТРОЕНИЕ АССИМИЛИРУЮЩИХ ОРГАНОВ *PHYSALIS ANGULATA* L. ПРОИЗРАСТАЮЩЕГО В УСЛОВИЯХ УЗБЕКИСТАНА. *Innovations in Technology and Science Education*, 2(8), 846–855. Retrieved from <https://humoscience.com/index.php/itse/article/view/652>
12. Хикматуллаев И.Л., Бобакулов Х.М., Сасмаков С.А., Арипова С.Ф. Химические компоненты растения *Physalis alkekengi* флоры Узбекистана. // *O'zbekiston biologiya jurnali*. —2021. —№6. —С.3-7.
13. Хикматуллаев И.Л., Терентьева Е.О., Арипова С.Ф. Алкалоиды растения *Physalis alkekengi* семейства *Solanaceae* флоры Узбекистана и их цитотоксическая активность. // Доклады Академии наук Республики Узбекистан. —2021. —№6. —С.50-52.
14. Хикматуллаев И.Л., Эсанов Р.С., Матчанов А.Д., Арипова С.Ф. Исследование микронутриентов растений *Physalis alkekengy* и *Ph. angulata*. // Доклады Академии наук Республики Узбекистан. —2021. —№3. —С.45-48.
15. Xikmatullayev I.L., Asqarov I.R., Xo'jayev V.U., Aripova S.F. O'zbekiston florasining *Physalis angulata*, *Physalis alkekengi* o'simlik alkaloidlari va ularning sitotoksik faolligi. // "Kimyo va kimyo ta'limi muammolari" mavzusidagi respublika ilmiy – amaliy anjuman materiallari. —Qo'qon. 20 sentabr, 2022. —B.178-179.



16. Xikmatullayev I.L., Asqarov I.R., Xo'jayev V.U., Aripova S.F. *Physalis alkekengi* o'simligi flavonoid tarkibi taxlili. // "Kimyo va kimyo ta'limi muammolari" mavzusidagi respublika ilmiy – amaliy anjuman materiallari. Qo'qon. 20 sentabr, 2022. – B.161-163
17. Xikmatullayev I.L., Asqarov I.R., Xo'jayev V.U. *Physalis angulata* o'simligi flavonoid tarkibi taxlili. // "Товарлар кимёси ҳамда халқ табобати муаммолари ва истиқболлари" мавзусидаги IX Халқаро илмий-амалий конференция материаллари. —Андижан. 15-16 сентябрь, 2022. —Б 197-199.
18. Хикматуллаев И.Л., Хужаев В.У. Флавоноиды растений *Physalis alkekengi* семейства *Solanaceae*. // "Global science and innovation 2021: Central Asia" International scientific - practical journal. —2021. —№1(12). —P.42-43.
19. Khikmatullaev I.L., Bobakulov H.M., Khuzhaev V.U., Aripova S.F. Chemical composition of benziine fraction of leaves and roots extract of *Physalis alkekengi*. // 14th international Symposium on the Chemistry of Natural Compounds. —Tashkent. October 7-8, 2021. —P.50.
20. Xikmatullayev I.L., Xo'jayev V.U., Aripova S.F. *Physalis alkekengi* o'simligi vitamin tarkibi taxlili. // "Bioorganik kimyoning dolzarb muammolari" mavzusidagi xalqaro miqyosdagi ilmiy va ilmiy-texnik anjumani materiallari. —Farg'ona. 23 noyabr, 2021. —B.229-231.
21. Xikmatullayev I.L., Xo'jayev V.U., Aripova S.F. *Physalis angulata* o'simligi mikroelementlarining mass-spektrometriya taxlili. // "Товарлар кимёси ҳамда халқ табобати муаммолари ва истиқболлари" мавзусидаги VIII-республика илмий-амалий конференция материаллари. —Андижан. 15-16 сентябрь, 2021. —Б 194-197.
22. Хикматуллаев И.Л., Хўжаев В.У., Арипова С.Ф. *Physalis angulata* ўсимлик экстракти олиш усулини оптимиллаштириш. // "Ўзликсиз билимлендириш системасында аралықтан оқытыўдың интеграциясы" атамасында өткерилетуғын халықаралық илимий-теориялық конференция. —Тошкент. 21 феврал, 2021. —Б.256-258.
23. Хикматуллаев И.Л., Хўжаев В.У., Арипова С.Ф. *Physalis alkekengi* ўсимлик экстракти олиш усулини оптимиллаштириш. // "Ўзликсиз билимлендириш системасында аралықтан оқытыўдың интеграциясы" атамасында өткерилетуғын халықаралық илимий-теориялық конференция. —Тошкент. 21 феврал, 2021. —Б.252-254.
24. Xikmatullayev I.L., Xo'jayev V.U., Aripova S.F. *Physalis alkekengi* o'simligi mikroelementlarining mass-spektrometriya taxlili. // "Кимё-технология фанларининг долзарб муаммолари" мавзусидаги халқаро



- олимлар иштирокидаги Республика илмий-амалий анжумани.
—Тошкент. 10-11 март, 2021. —Б.569.
25. Hikmatullayev I.L., Xo‘jayev V.U., Aripova S.F. *Physalis alkekengi* roya ekstrakti benzinli fraksiyasining kimyoviy tarkibi. // “Ўзбекистонда табиий бирикмалар кимёсининг ривож ва келажаги” Илмий-амалий конференцияси материаллари тўплами. —Тошкент. 27 май, 2021. —Б.31-32.
 26. Hikmatullayev I.L., Xo‘jayev V.U. O‘zbekiston hududida o‘suvcchi *Physalis alkekengi* o‘simlik alkaloidlari. // Qo‘qon DPI. Ilmiy xabarlar. —2021. —№1. —Б.23-25.
 27. Хикматуллаев И.Л., Хўжаев В.У., Арипова С.Ф. Solanaceae oilasiga mansub *Physalis angulata* va *Physalis alkekengi* tarkibini fitokimyoviy tahlili. // “Товарлар кимёси ҳамда халқ табобати муаммолари ва истиқболлари” мавзусидаги VII Халқаро илмий-амалий конференция материаллари. —Андижан. 18-19 сентябрь, 2020. —Б 62-64.
 28. Hikmatullayev I.L., Xo‘jayev V.U. *Physalis alkekengi* va *Physalis angulata* o‘simliklari biologik tavsifi va fiziologik faolligi. // Qo‘qon DPI. Ilmiy xabarlar. —2020. —№1. —Б.79-81.
 29. Hikmatullayev I.L., Xo‘jayev V.U. *Physalis alkekengi* L.var.franchetii o‘simligi fitokimyoviy va farmakologik tekshiruv. // “Инновации в науке и образовании” II Республиканской научно-практической интернет-конференции с международным участием. —Андижан. 20 август, 2020. —Б.5-6.
 30. Hikmatullayev I.L., Xo‘jayev V.U. Solanaceae oilasiga mansub *Physalis angulata* L. // “Ўзбекистонда илмий-амалий тадқиқотлар” мавзусидаги конференция материаллари. —Тошкент. 31-июль, 2020. —Б.7.
 31. Hikmatullayev I.L., Xo‘jayev V.U. *Physalis angulata* ikkilamchi metabolit tarkibiy qismlarining antibakterial faolligi. // “Ўзбекистонда илмий-амалий тадқиқотлар” мавзусидаги конференция материаллари. —Тошкент. 31-август, 2020. —Б.11.
 32. Batirovna, Karimova Dilovar, Saidahmedova Nurxon Yusupovna, and Mahmudov Ilhomjon Tolibjonovich. "Research of the chemical composition of perfumery products." *Spectrum Journal of Innovation, Reforms and Development* 9 (2022): 271-277.
 33. Karimova, D. B., & Khuzhaev, V. U. (2021). DETERMINATION OF PARABENS IN COSMETICS. *SCOPE ACADEMIC HOUSE B&M PUBLISHING*, 26.
 34. Закирова, Г. И. К., Каримова, Д. Б., & Хужаев, В. У. (2025). ИССЛЕДОВАНИЕ АМИНОКИСЛОТНОГО СОСТАВА РАСТЕНИЙ



- ЕРИОВОТРУА ЈАРОНІСА ПРОІЗРАСТАЮЩИХ В
УЗБЕКИСТАНЕ. *Universum: технические науки*, 5(2 (131)), 62-66.
35. Каримова Д.Б., Бурханова Х.В. АМИНОКИСЛОТНЫЙ СОСТАВ
СЕМЕНА ГОРЬКОГО МИНДАЛЯ // *Universum: химия и биология* :
электрон. научн. журн. 2024. 6(120).